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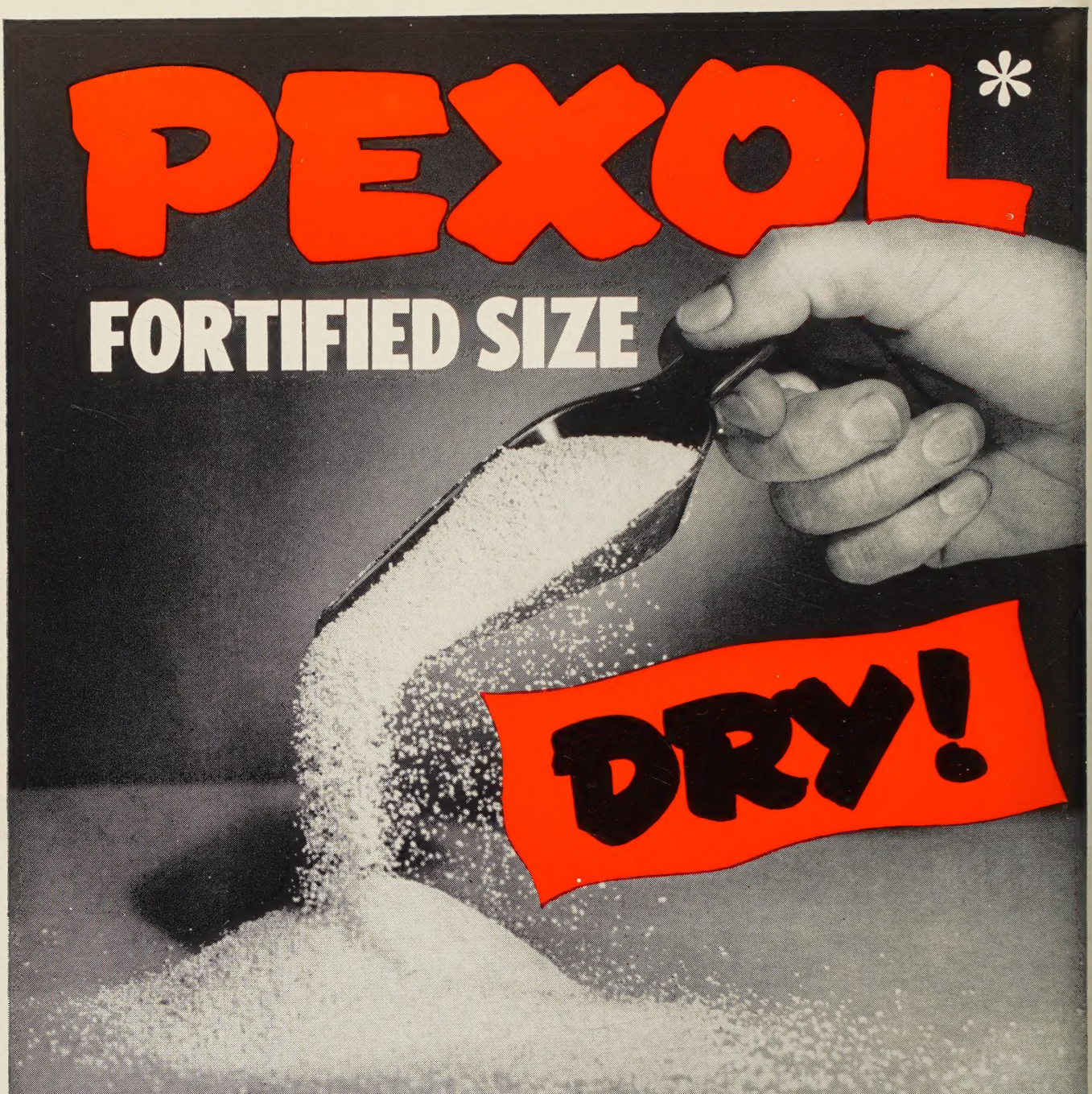
PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MAY 1953



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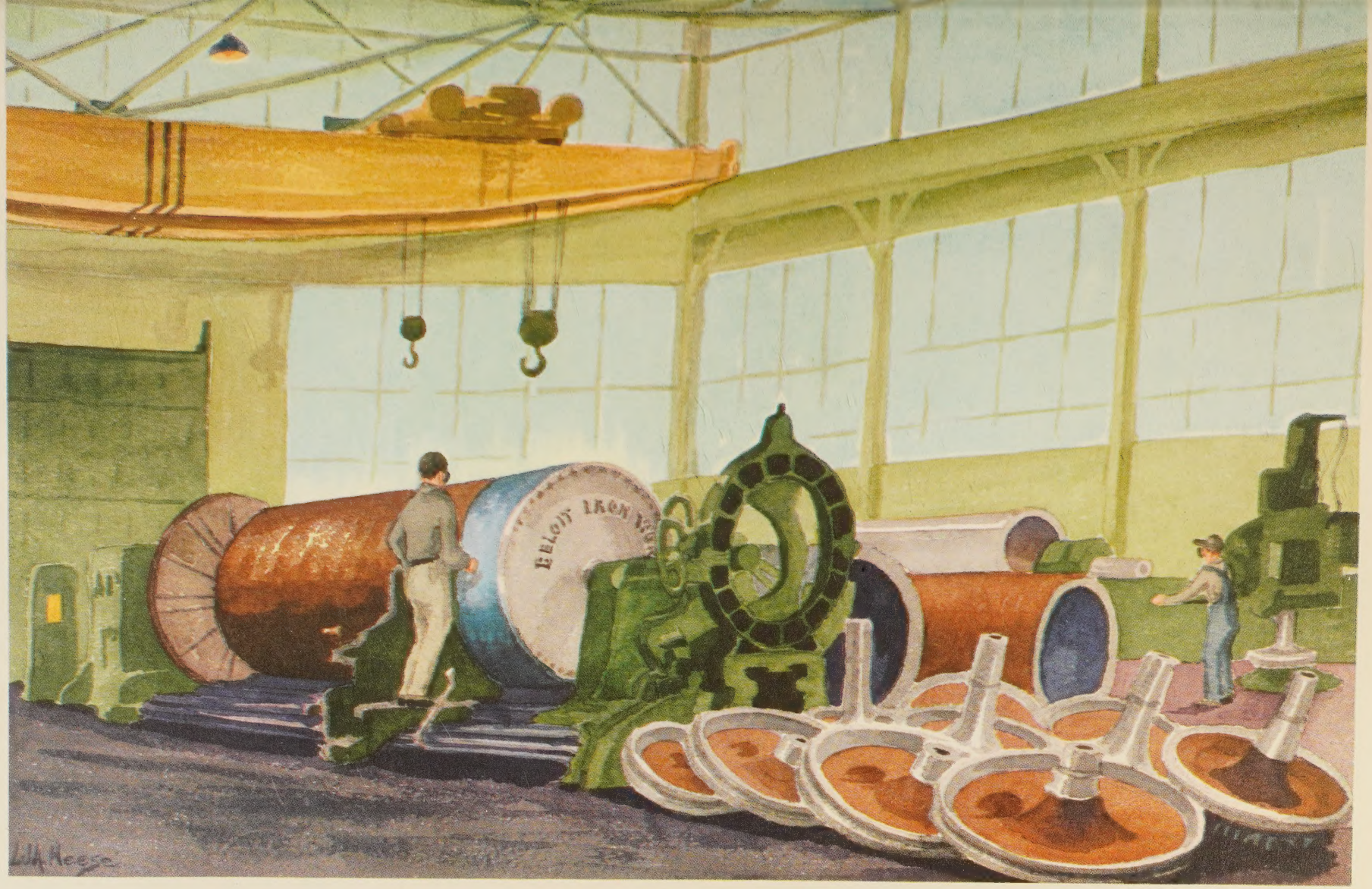

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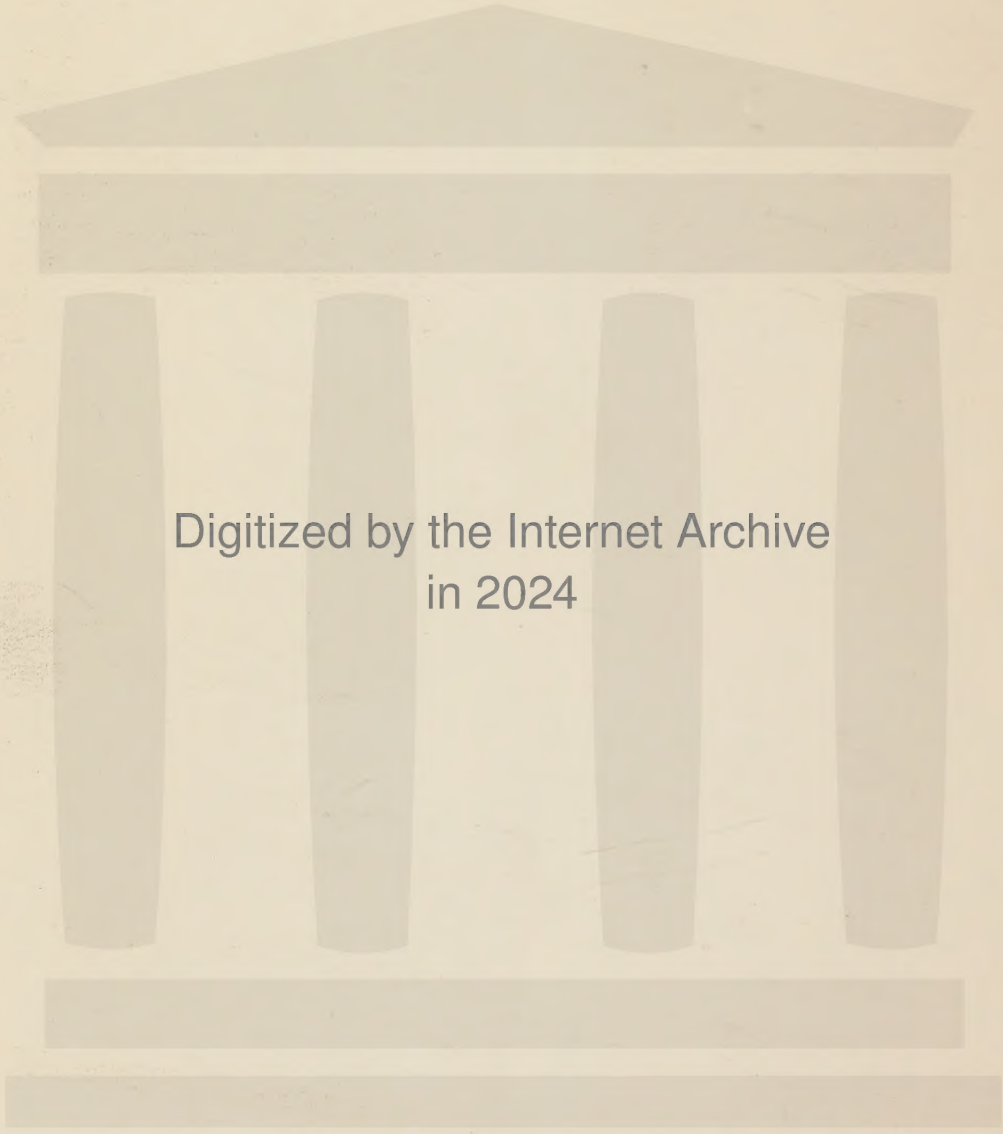

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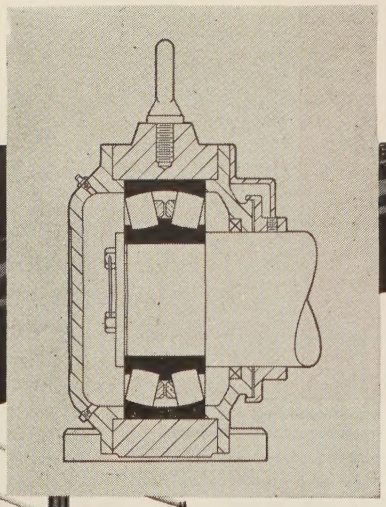

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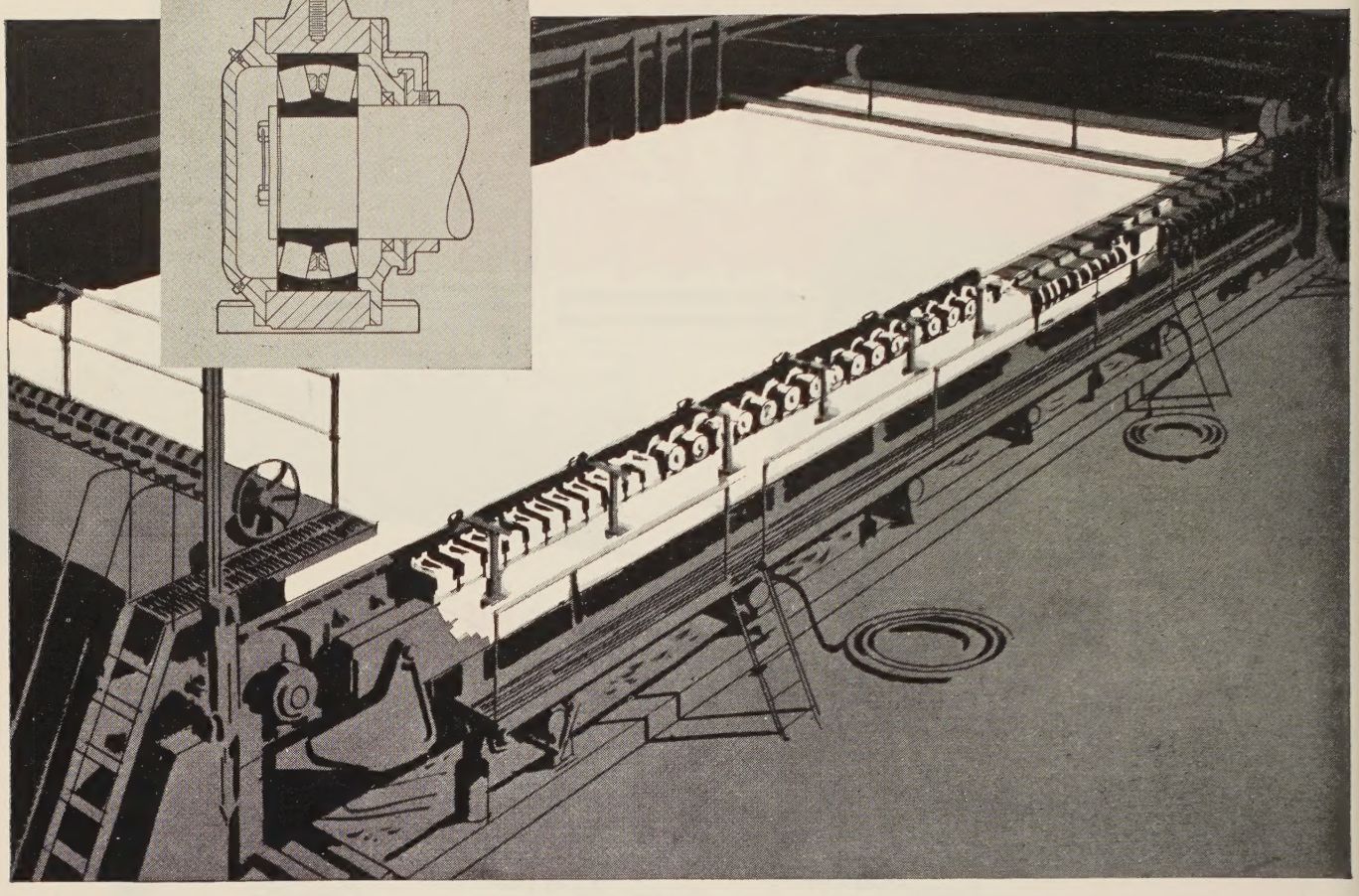

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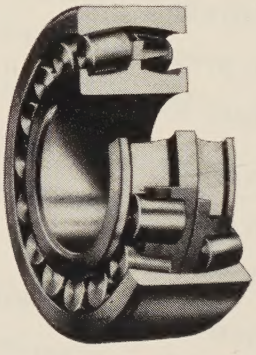

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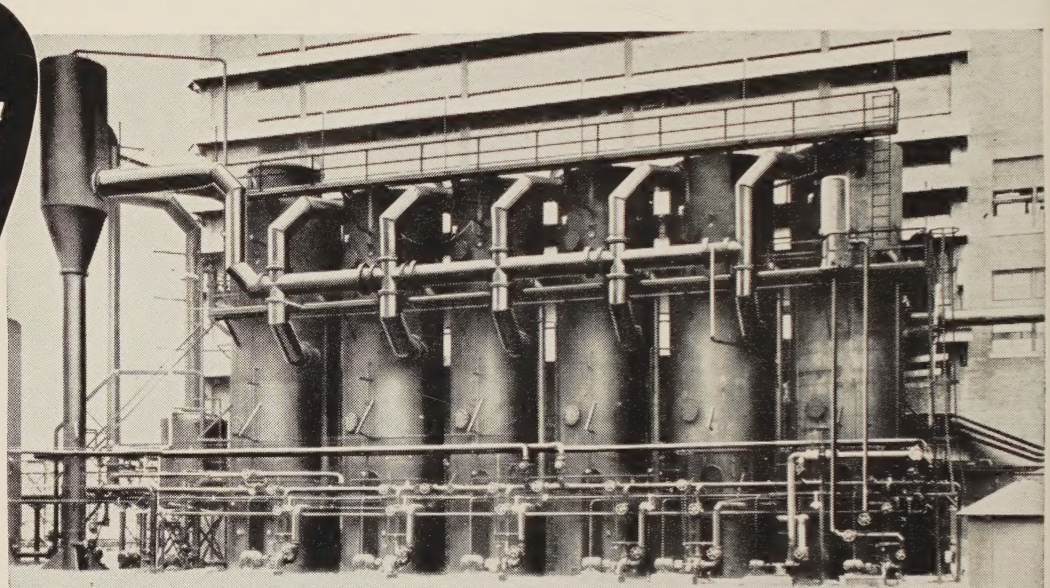

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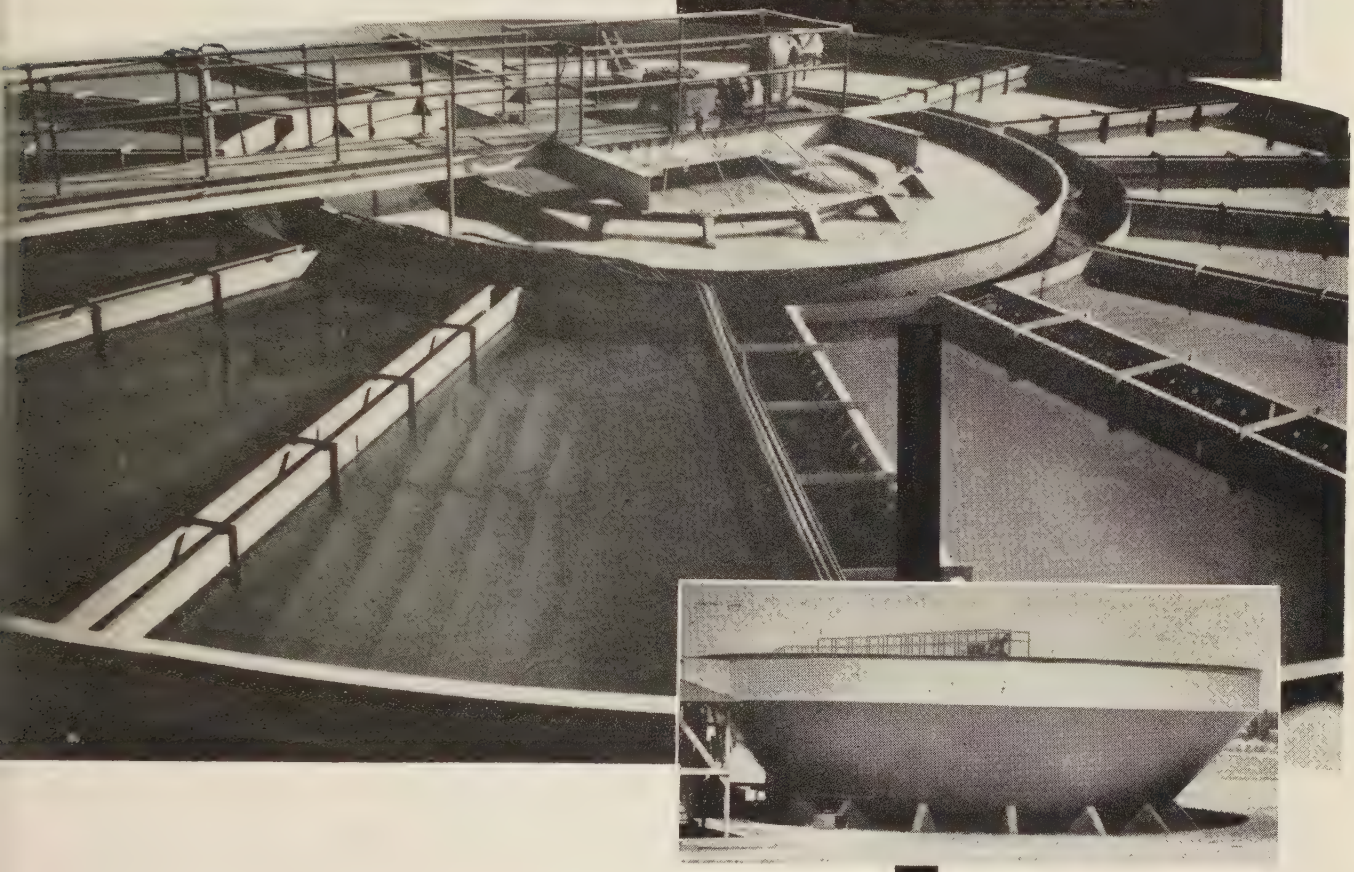

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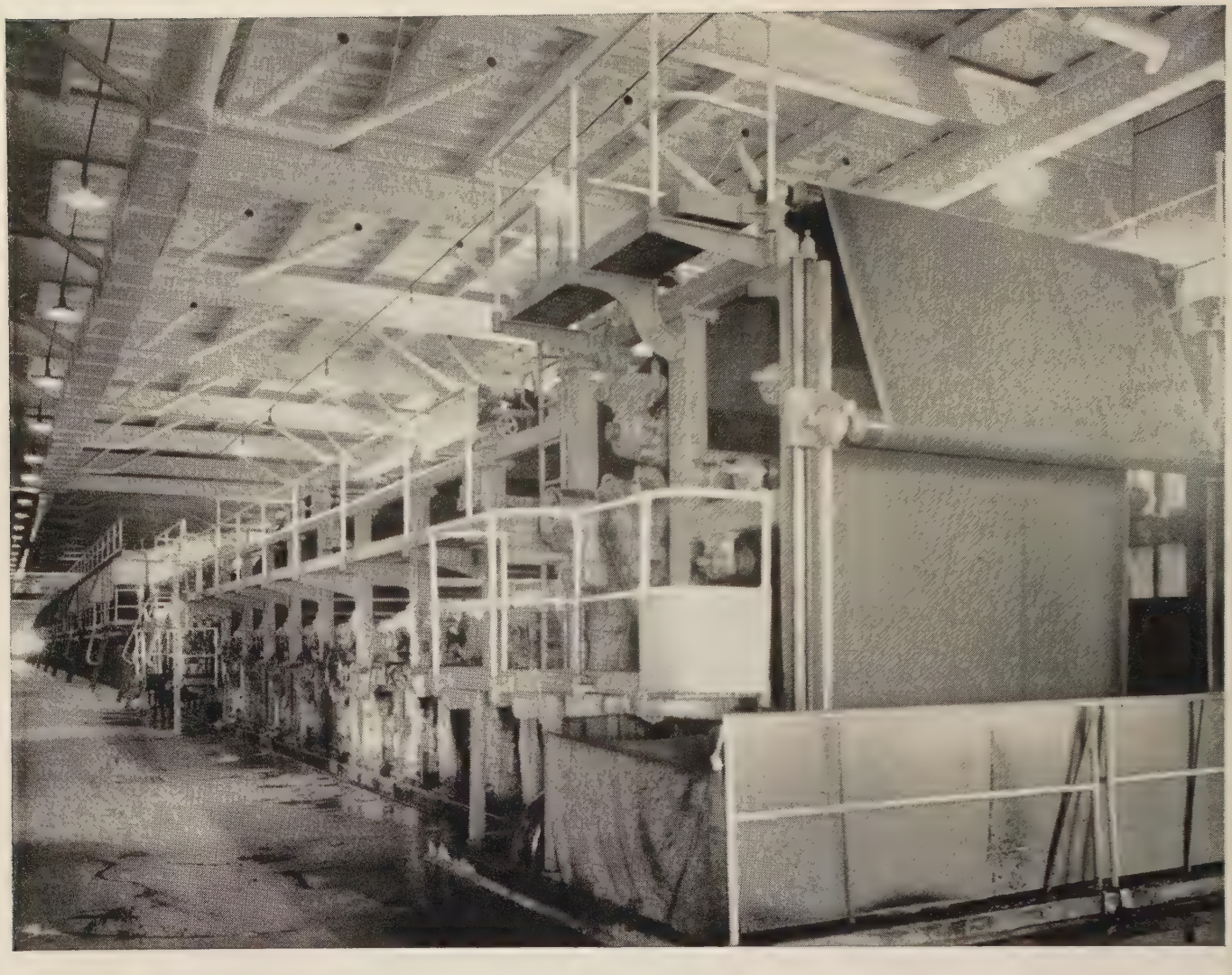

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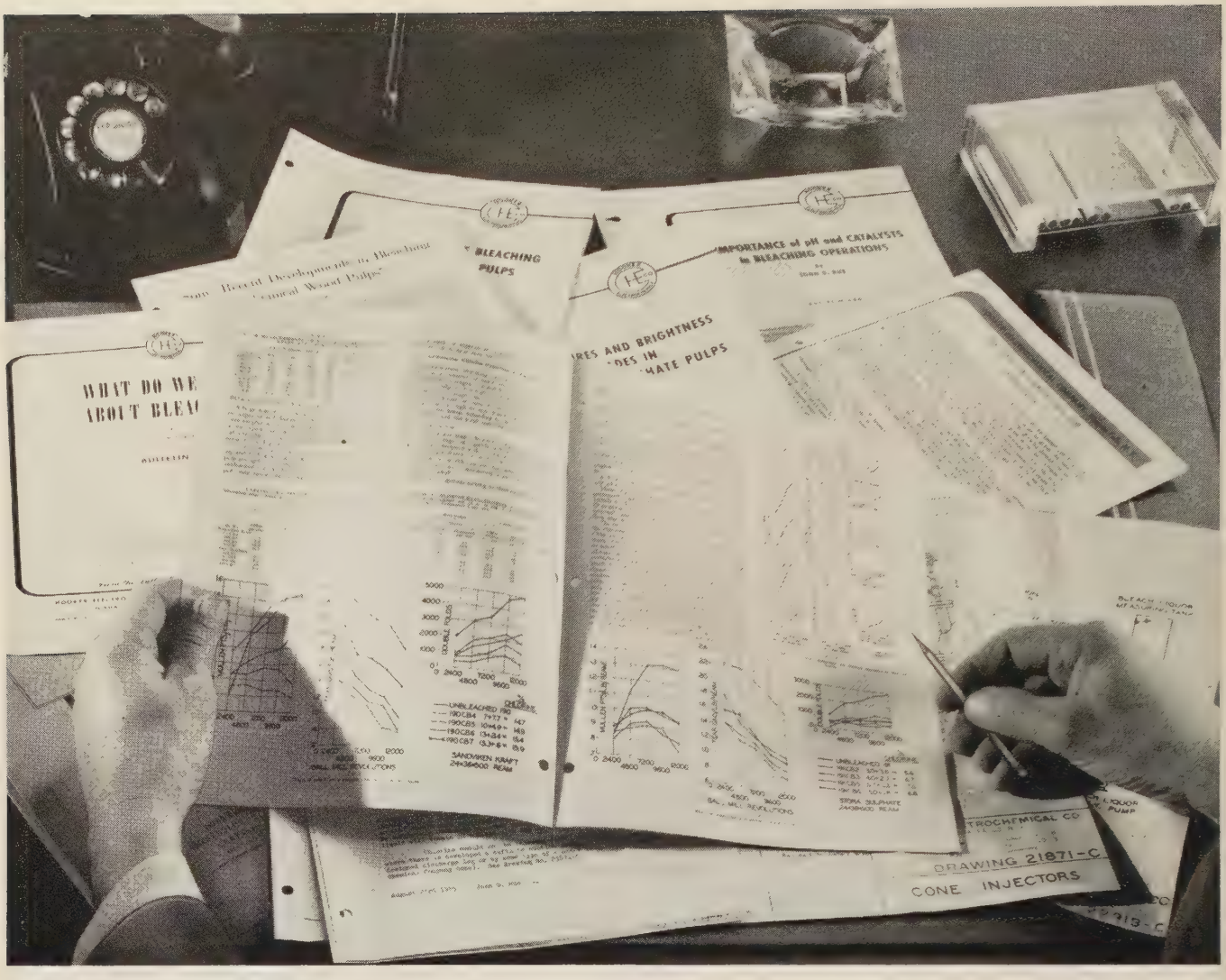

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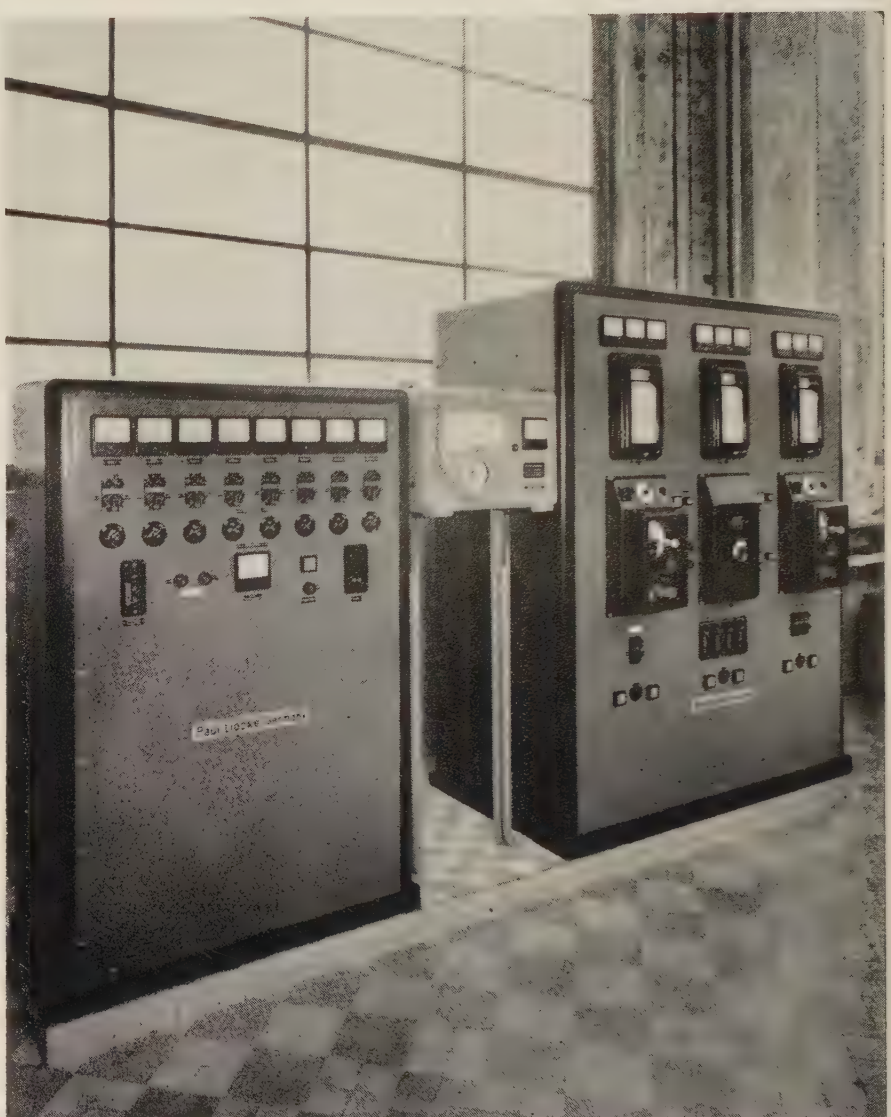

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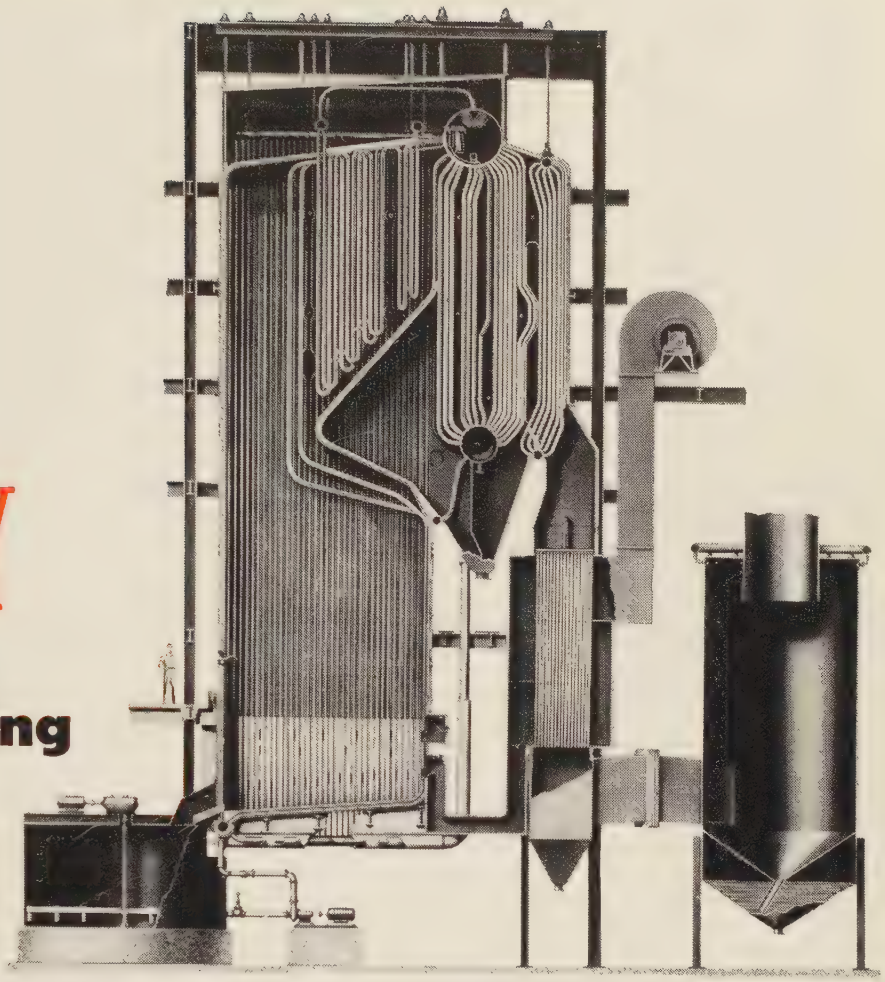

Typical B&W Black Liquor Recovery Unit

Airview of Roaring Spring, Pa., plant of The D. M. Bare Paper Company

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PULP, PAPER, AND BOARD IN THE UNITED STATES

Review for 1952

W. LEROY NEUBRECH

TOTAL consumption of paper and board in the United States in 1952 and 1951 was approximately 30 million tons for each year. Of the annual total, approximately 5 million tons consisted of imported newsprint. Exports and imports of other grades of paper and paperboard are comparatively small.

The assumption that total paper and board consumption in the United States in 1952 was close, if not almost identical, to that in 1951 is based upon an observation of the level of the Federal Reserve Board index of industrial production for these years which was 220 for 1951 and 219 for 1952 (1935–39 equals 100).

For a number of years there has been a very close correlation between the actual level of paper and board consumption in the United States and the index of industrial production of all types of manufactured goods, including food products. Particularly during the last decade, more and more durable goods are being packaged in some form in paper or paperboard containers. Even heavy durables, such as automobiles, have an important relationship to paper and board. A surprisingly large tonnage of paperboard is used for interior trim in automobile, bus, and truck bodies. Furthermore, prefabricated automotive parts sent to assembly plants are customarily packaged, while the necessary accessories and parts delivered to retail automotile dealers are also packaged. This observation is also true with regard to many other industrial areas where it was formerly thought that paper or paperboard was not an important element in manufacture or distribution.

In other words, the index of total industrial production is proving to be a better measure of aggregate paper and board consumption than merely the nondurable segments of the index. For individual grades, or grade groups, there may be other indexes which would prove more accurate and present a better correlation.

It is noteworthy, however, that United States production of paper and board in 1952 totaled only 24.4 million tons against 26.0 million tons in 1951, a decline of 6.3%. It would appear, therefore, based upon the observation that United States consumption of paper and board (exclusive of imported newsprint) totaled approximately 25 million tons in both of these years, that inventories to the extent of about 1 million tons were accumulated in 1951, while during 1952 about the same amount of inventories were used up.

It is, of course, impossible to forecast exact consumption or production for an ensuing year. However, the level of production as reported by trade association groups for the first 12 weeks of 1953, plus private economic forecasts of increased industrial activity in 1953, support an estimate that total United States consumption of paper and board in 1953 will be in the neighborhood of 41.5 million tons. Of this, about 5.2 million tons would be imported newsprint and 26.3 million tons domestic production of all grades. This estimate is based upon the assumption that the international situation will not change materially, that there will be no major domestic labor disputes, and that defense expenditures will continue as scheduled. It is also assumed that there will be no significant inventory buying cycle or any further reason why inventories should be reduced below current ratios to sales.

Table I. Statistical High Lights

Item and unit	*1952*	*1951*	*Per cent change*
Pulpwood:			
Receipts, 1000 cords	27,358	27,778	− 1.5
Consumption, 1000 cords	26,462	26,522	− 0.2
Inventories (end of period), 1000 cords	5,949	5,072	+17.3
Wood pulp (total integrated and market):			
Production, 1000 short tons	16,467	16,524	− 0.3
Imports, 1000 short tons	1,937	2,361	−18.0
Exports, 1000 short tons	212	200	+ 6.0
New supply,[a] 1000 short tons	18,192	18,685	− 2.6
Consumption, total, 1000 short tons	18,026	18,451	− 2.3
Paper and board, 1000 short tons	17,274	17,737	− 2.6
Nonpaper, 1000 short tons	752	714	+ 5.3
Inventories, total (end of period), 1000 short tons	818	689	+18.7
Pulp, 1000 short tons	143	98	+45.9
Paper and board, 1000 short tons	568	513	+10.7
Nonpaper, 1000 short tons	107	78	+37.2
Market wood pulp (at paper and board mills):			
Receipts, 1000 short tons	2,279	2,819	−19.2
Consumption, 1000 short tons	2,252	2,742	−17.9
Inventories (end of period), 1000 short tons	404	395	+ 2.3
Market wood pulp (at nonpaper mills):[b]			
Receipts, 1000 short tons	781	731	+ 6.8
Consumption, 1000 short tons	752	714	+ 5.3
Inventories (end of period), 1000 short tons	107	78	+37.2
Wastepaper:			
Receipts, 1000 short tons	7,813	9,252	−15.6
Consumption, 1000 short tons	7,881	9,071	−13.1
Inventories (end of period), 1000 short tons	522	589	−11.4
Paper and board production:			
Total	24,413	26,048	− 6.3
Paper, 1000 short tons	10,896	11,625	− 6.3
Paperboard, 1000 short tons	10,776	11,620	− 7.3
Wet machine, 1000 short tons	137	148	− 7.4
Construction paper and board, 1000 short tons	2,604	2,655	− 1.9
Wholesale paper and paper products:			
Sales, 1,000,000 dollars	2,195	2,400	− 8.5
Inventories (end of period), 1,000,000 dollars	248	243	+ 2.0

[a] New supply equals production plus imports minus exports. [b] Data not comparable, 1952 data represent more complete coverage of this industry.
Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from Bureau of the Census, U. S. Dept. of Commerce.

The 1951 inventory buying episode was particularly evident in the first half of that year. It was brought about in large measure by uncertainties as to Government controls and complexities in the international situation. The aftermath of this inventory build-up was a production letdown in late 1951

W. LEROY NEUBRECH, Special Assistant to Director, Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, U. S. Dept. of Commerce, Washington, D. C.

Gouverneur Talc Co., Gouverneur, N. Y.

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New York State Talc
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—Uniform Quality—

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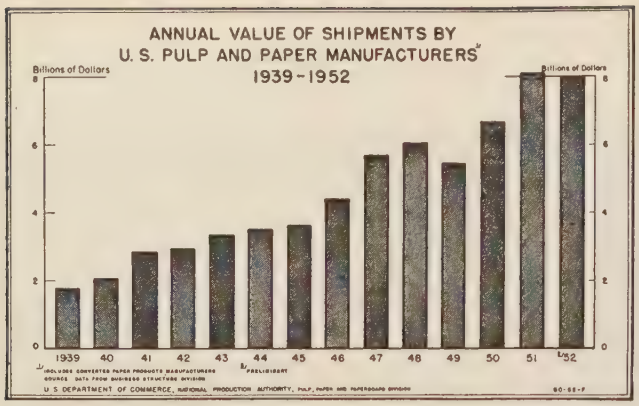
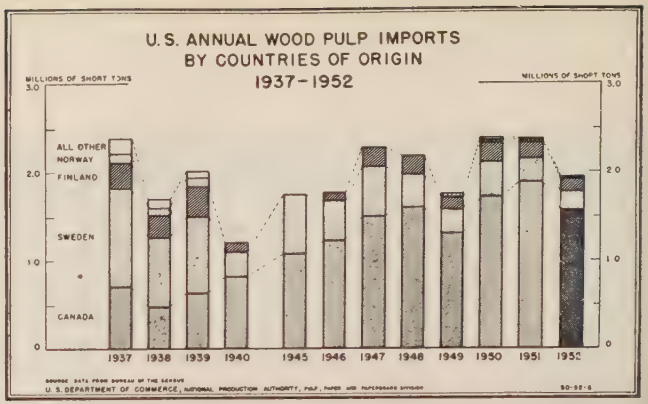

ANNUAL VALUE OF SHIPMENTS BY
U. S. PULP AND PAPER MANUFACTURERS
1939-1952
Billions of Dollars
1939 40 41 42 43 44 45 46 47 48 49 50 51 52
U. S. DEPARTMENT OF COMMERCE, NATIONAL PRODUCTION AUTHORITY



which lasted through September, 1952, particularly in the area of paperboard. Under normal conditions, such inventory cycles are unhealthy for the economy as a whole, particularly when such cycles occur in many other industries at the same time. This subject was explored in detail in the December, 1952, issue of the "Pulp, Paper, and Board Industry Report," where it was pointed out that a more complete statistical series on paper and paperboard inventories through converting and distribution channels would aid business to determine its policies regarding procurement and stocks. Maintenance of current statistics would help individual manufacturers, converters, distributors, and consumers to make intelligent decisions, and would help to reduce future inventory cycles.

Even though production of paper, board, and its products in 1952 was lower in volume than in 1951, the industry remained in the $8 billion bracket of total sales. The highest point reached was the 1951 record of $8.4 billion. A part of the decline in value in 1952 can be attributed to moderate declines in the price levels of most grades of paperboard, as well as some grades of paper, together with declines in the price of a number of converted products. Raw materials, such as wood pulp and wastepaper, also recorded price drops. There was a reported easing in pulpwood prices during 1952 in some regions.

One of the most interesting observations pertaining to the industry in 1952 is that, even though total paper and board production declined about 6% below 1951, wood pulp consumption dropped only 2% and United States wood pulp production declined only 0.3%. On the other hand, even though total wood pulp consumption declined very little, consumption of purchased (market) wood pulp at paper and board mills dropped nearly 18% below 1951. Consumption of wastepaper dropped 13% in like comparison. These statistical facts indicate that the nonintegrated segment of the industry, which depends in large measure upon purchased wood pulp and wastepaper as their principal raw materials, did not maintain the same relative level of production in 1952 as did the large mass-producing integrated mills. In the field of container board in particular it seems evident that the larger and newer kraft board mills were able to maintain a much better operating position than the nonintegrated jute container mills. A similar situation apparently existed with respect to other grades of paper and board.

It is apparent that the United States is growing more and more independent of overseas wood pulp. In 1952, total consumption of wood pulp for all uses amounted to slightly over 18 million tons. Of this quantity, 1.9 million tons were imported of which only 360 thousand tons originated from overseas with the balance from Canada. The large expansion in domestic pulp, paper, and paperboard production facilities during the past two years, as well as projects now under way or scheduled for development during the next couple of years, may mean that the United States will be largely independent of overseas supplies of wood pulp. It is anticipated that the new domestic pulp-producing facilities will exceed the needs of integrated facilities and that sufficient supplies will be offered on the market to meet the requirements of the nonintegrated mills ordinarily coming from overseas sources. On the other hand, Canada will continue as an important source

Table III. Total Value of Sales of the Pulp, Paper, Board, and Products Manufacturing Industry

Year	*Millions of dollars*	*Year*	*Millions of dollars*	*Year*	*Millions of dollars*
1939	1785	1944	3629	1949	5448
1940	2064	1945	3725	1950	6671
1941	2836	1946	4469	1951	8432
1942	2965	1947	5764	1952[a]	8023
1943	3389	1948	6060		

[a] Preliminary.
Source: Office of Business Economics, Dept. of Commerce. The estimated dollar total of sales represents receipts of all operators of paper manufacturing companies. The figures include data for both corporate and noncorporate businesses but are comparable to the sales data for corporations in Statistics of Income published by the Bureau of Internal Revenue.

Table IV. Total United States Imports and Exports, Paper Base Stocks, Paper, and Manufactures

(In Millions of Dollars)

Year	*Imports*	*Exports*	*Year*	*Imports*	*Exports*
1939	215	40	1949	666	113
1945	298	102	1950	746	107
1946	419	116	1951	958	231
1947	657	173	1952[a]	925	193
1948	754	139			

[a] Preliminary.
Source: Bureau of the Census, U. S. Dept. of Commerce.

Table II. Pulp, Paper, and Board High Lights

Item	*Unit, millions of—*	*1952*	*1951*	*1950*	*1949*	*1948*	*1947*	*1939*
Pulpwood consumption	Cords	26.4	26.5	23.6	19.9	21.2	19.7	10.8
Wood pulp production	Tons	16.5	16.5	14.8	12.2	12.9	11.9	7.0
Wood pulp consumption[a]	Tons	17.3	17.7	16.5	13.6	14.4	13.3	8.7
Wastepaper consumption[a]	Tons	7.9	9.1	8.0	6.6	7.6	8.0	4.4
Paper and board production	Tons	24.4	26.0	24.4	20.3	21.9	21.1	13.5
Wood pulp imports	Tons	1.9	2.4	2.4	1.8	2.2	2.3	2.0
Newsprint imports	Tons	5.0	5.0	4.9	4.6	4.4	4.0	2.6

[a] In manufacture of paper and board only.
Source: Bureau of the Census, U. S. Dept. of Commerce.

National Basic Dyes recommended for Colored Groundwood Specialties

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NATIONAL CHRYSOIDINE YP CONC. NEW

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NATIONAL BISMARCK BROWN RP CONC.

NATIONAL SAFRANINE AP CONC.

NATIONAL RHODAMINE BP EXTRA

NATIONAL FUCHSINE SBP

NATIONAL METHYL VIOLET 2BP CONC.

NATIONAL CRYSTAL VIOLET 6BP CONC.

NATIONAL VICTORIA PURE BLUE BOP

NATIONAL VICTORIA BLUE BP CONC.

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NATIONAL VICTORIA GREEN WBP CRYSTALS

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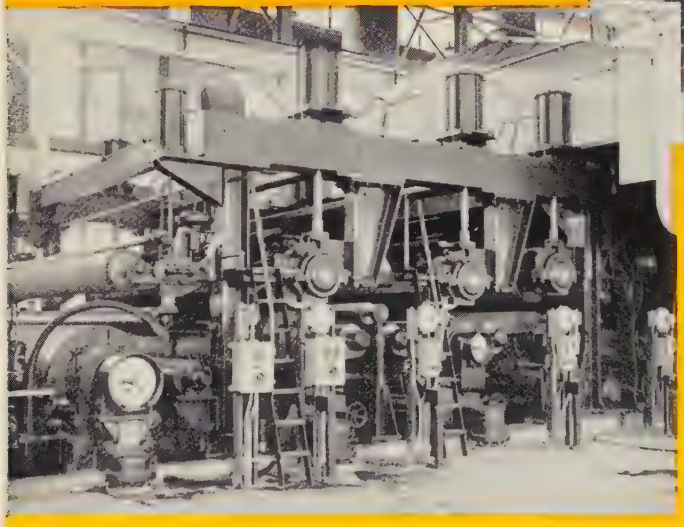
Press Part with two Suction Presses and reversed third press. A pneumatic controlled water-marking device operates in connection with the third press.

Press Part with four suction rolls, two in combination with a common center roll in vacuum pick-up arrangement.



Simplex Press Part showing improved Lump Breaker and Couch Draw Roll arrangement.

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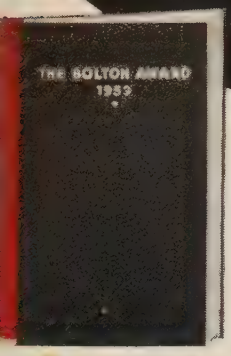


John W. BOLTON & Sons, Inc.

Lawrence, Massachusetts, U.S.A.

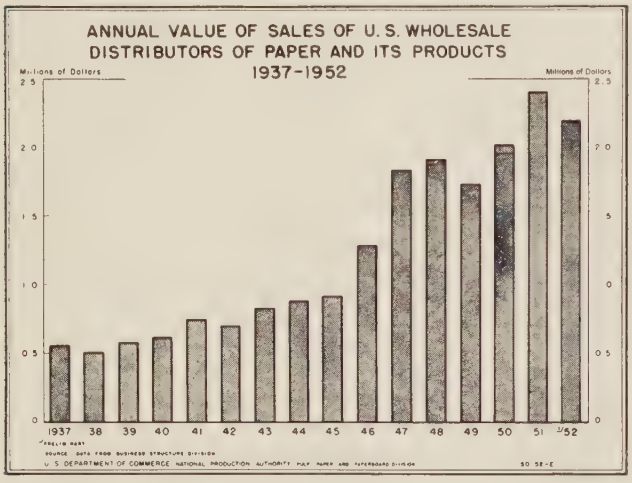
Table V. Annual Value of Sales of United States Wholesale Distributors of Paper and Its Products, 1939–52

Year	Millions of dollars	Year	Millions of dollars	Year	Millions of dollars
1939	575	1944	878	1949	1723
1940	608	1945	909	1950	2013
1941	739	1946	1275	1951	2400
1942	695	1947	1828	1952[a]	2195
1943	823	1948	1902		

[a] Preliminary.
Note: These data are revised to 1948 Census of Business data.

of wood pulp inasmuch as a large part of imports from Canada are from pulp mills integrated with United States consuming mills.

The wastepaper industry suffered a sharp decline in 1952 compared to 1951, brought about largely by the recession in the operation of paperboard mills. Receipts of wastepaper at mills totaled only 7.8 million tons compared with 9.3 million tons in 1951. There are many problems involved in the cycles in wastepaper receipts, consumption, and inventories which have occurred over a period of years. These


ANNUAL VALUE OF SALES OF U. S. WHOLESALE
DISTRIBUTORS OF PAPER AND ITS PRODUCTS
1937-1952
Millions of Dollars
Millions of Dollars
2.5
2.0
1.5
1.0
0.5
0
1937 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
U. S. DEPARTMENT OF COMMERCE NATIONAL PRODUCTION AUTHORITY PULP PAPER AND PAPERBOARD DIVISION
50-52-E

problems are receiving greater attention and, in fact, only recently there was established a new organization known as the Waste Paper Utilization Council. It is expected, even during its first year of operation, that significant results will be observed. Wastepaper is an important fibrous raw material which should be properly and profitably utilized as one means of conserving our over-all forest resources of wood fiber.

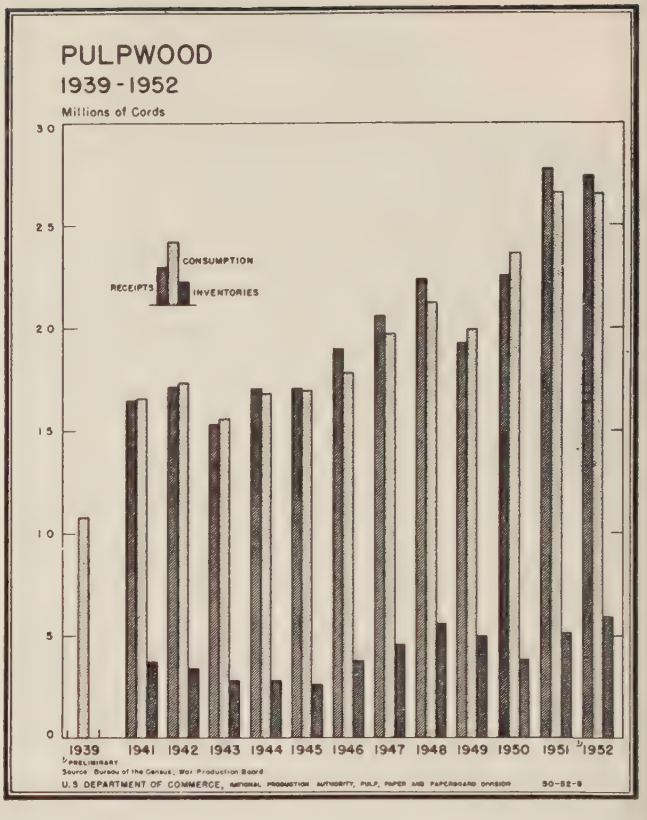
Adequate supplies of pulpwood continued available in 1952, although there was some decline in receipts because of the

Table VI. Monthly Value of Sales of United States Wholesale Distributors of Paper and Its Products, 1947–52[a]

(Millions of Dollars)

Month	1947	1948	1949	1950	1951	1952
January	135	163	148	148	228	192
February	123	152	136	139	198	178
March	134	159	148	151	218	185
April	144	157	137	143	199	185
May	146	151	131	149	211	176
June	151	161	139	162	202	165
July	150	144	125	151	178	163
August	154	163	152	194	208	179
September	176	166	152	186	183	198
October	188	169	154	205	217	210
November	163	162	155	198	194	180
December	164	155	146	187	164	184
Total	1828	1902	1723	2013	2400	2195

[a] Preliminary.
Note: These data are revised to 1948 Census of Business data.
Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority; from data supplied by Business Structure Div., U. S. Dept. of Commerce.



large inventories of pulpwood that had been accumulated during 1951, as well as in the first part of 1952. Consistent with the level of wood pulp production, pulpwood consumption in 1952 was almost identical to that in 1951. Marked strides were made by the industry during 1952 in acquisition of forest lands. These are being placed under sustained yield forestry practices. Also noteworthy were developments in closer utilization of timberlands for pulping purposes. For

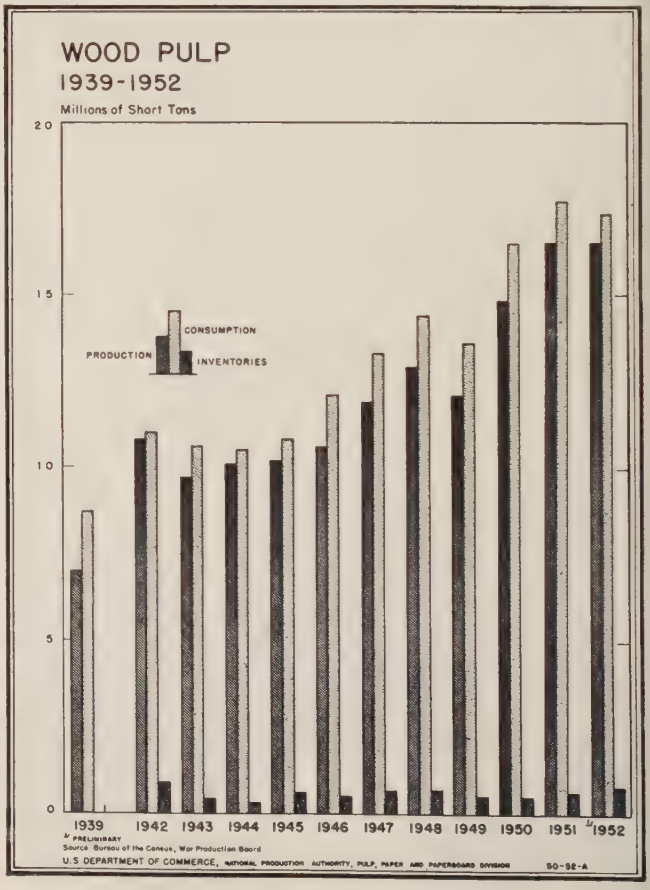


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Table VII. Pulpwood—United States Annual Receipts, Imports, Consumption, and Inventories, 1942–52

(1000 Standard Cords—Roughwood Basis)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
Receipts, total	27,358	27,778	22,546	19,266	22,333	20,619	18,978	16,982	16,999	15,292	17,139
Domestic	25,045	25,128	20,712	17,619	20,026	18,542	16,982	15,253	15,349	13,580	14,907
Imported	2,315	2,650	1,834	1,647	2,307	2,077	1,996	1,729	1,650	1,712	2,232
Northeast, total	4,740	4,723	3,295	3,275	4,039	4,135	3,650	3,389	3,039	2,953	3,399
Domestic	3,319	3,137	2,235	2,366	2,666	2,970	2,508	2,311	1,976	1,906	2,238
Imported[b]	1,422	1,586	1,060	909	1,373	1,165	1,142	1,078	1,063	1,047	1,161
Appalachian, total	1,562	1,960	1,705	1,544	1,784	1,623	1,716	1,388	1,482	1,304	1,475
Domestic	1,562	1,960	1,705	1,544	1,763	1,610	1,684	1,365	1,472	1,302	1,448
Imported[b]	....	....	....	....	21	13	32	23	10	2	27
Lake States, total	3,182	3,425	2,472	2,149	3,031	2,900	2,919	2,456	2,638	1,969	2,796
Domestic	2,445	2,622	1,985	1,619	2,344	2,154	2,239	1,954	2,175	1,409	1,983
Imported	739	803	487	530	687	746	680	502	463	560	813
South, total	13,381	12,844	11,543	9,060	9,997	8,227	7,909	7,153	7,090	6,505	6,622
Domestic	13,381	12,844	11,543	9,060	9,997	8,227	7,909	7,153	7,090	6,505	6,622
West, total[c]	4,494	4,826	3,531	3,238	3,482	3,734	2,784	2,596	2,750	2,561	2,847
Domestic	4,339	4,565	3,244	3,030	3,256	3,581	2,642	2,470	2,636	2,458	2,616
Imported	155	261	287	208	226	153	142	126	114	103	231
Consumption, total	26,462	26,522	23,627	19,945	21,189	19,714	17,818	16,913	16,758	15,645	17,275
Northeast	4,051	4,280	3,704	3,397	3,814	3,740	3,466	3,245	3,159	3,265	3,530
Appalachian	1,673	1,859	1,796	1,614	1,767	1,684	1,501	1,444	1,490	1,442	1,498
Lake States	2,909	3,039	2,825	2,461	2,821	2,724	2,554	2,544	2,474	2,325	2,471
South	13,330	12,854	11,480	9,255	9,443	8,395	7,516	7,208	7,153	6,342	6,804
West[c]	4,499	4,490	3,822	3,218	3,344	3,171	2,781	2,472	2,482	2,271	2,972
Inventories, total[d]	5,949	5,072	3,815	4,905	5,622	4,566	3,780	2,626	2,819	2,846	3,391
Northeast	1,937	1,483	1,051	1,520	1,644	1,442	1,063	869	700	820	1,119
Appalachian	323	367	249	332	397	372	422	206	279	280	423
Lake States	1,701	1,380	986	1,343	1,674	1,487	1,350	986	1,088	962	1,313
South	856	772	753	670	828	291	526	145	218	293	126
West[c]	1,133	1,070	776	1,040	1,079	974	419	420	534	491	410

[a] Preliminary. [b] Imports to Appalachian region included in Northeast to avoid disclosure of individual company data. [c] Converted 600 board feet equal 1 cord. [d] End of year.

Note: Detail may not add to totals because of rounding.

Sources: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority: Data covering 1942–44, inclusive—Forest Products Bureau, War Production Board. Data covering 1945–52, inclusive—Bureau of the Census, U. S. Dept. of Commerce.

Table VIII. Wood Pulp—United States Annual Imports and Exports, 1942–52

(1000 Short Tons)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
Imports, total	1937	2361	2385	1763	2176	2322	1805	1754	1072	1306	1237
Bleached sulphite: rayon and special chemical grades	223	231	239	154	235	249	202	146	133	129	134
Bleached sulphite: other	277	349	402	331	323	288	223	242	188	231	241
Unbleached sulphite	432	557	529	392	675	732	618	657	399	519	459
Bleached sulphate	519	522	450	392	278	239	80	72	47	48	58
Unbleached sulphate	208	336	440	249	336	470	398	380	99	105	91
Soda	28	33	34	27	25	21	20	21	16	20	18
Chemical screenings	4	10	5	3	8	10	9	7	7	11	8
Bleached mechanical	34	18	20	1	..	..	1	1	[b]	..	[b]
Unbleached mechanical	208	300	260	208	291	309	249	222	177	236	220
Mechanical screenings	4	5	6	6	5	5	6	5	5	6	7
Exports, total	212	200	96	122	94	130	39	135	218	301	378
Bleached sulphite: rayon and special chemical grades	65	31	28	25	18	11	8	13	11	23	29
Bleached sulphite: other	24	44	18	20	13	44	7	17	38	45	78
Unbleached sulphite	35	44	33	39	54	54	17	27	46	90	98
Bleached sulphate	12	9	5	9	1	2	1	6	7	16	28
Unbleached sulphate	75	69	9	27	6	17	5	60	106	121	140
Soda	1 [c]	1	[b]	[b]	1	1	[b]	11	11	5	3
Screenings and other wood pulp	..	2	2	1	1	2	1	1	[b]	1	1

[a] Preliminary. [b] Less than 500 tons. [c] Includes "screenings and other wood pulp."

Note: Detail may not add to total because of rounding.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census, U. S. Dept. of Commerce.

Table IX. Total United States Annual Wood Pulp Imports, All Grades—by Major Countries of Origin

(1000 Short Tons)

Country	1952[a]	1951	1950	1949	1948	1947	1946	1945	1941	1940
Total	1937	2361	2385	1763	2176	2322	1805	1754	1158	1225
Canada[b]	1578	1877	1717	1314	1601	1529	1245	1082	1145	828
Sweden	190	258	398	266	385	555	445	672	..	279
Finland	145	183	206	149	176	224	115	..	13	93
Norway	21	36	29	29	13	10	..	..	..	17
All other	3	7	35	5	2	5	..	..	..	8

[a] Preliminary. [b] Includes Newfoundland.

Note: Detail may not add to totals because of rounding.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census, U. S. Dept. of Commerce.

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NEW Enclosed Type Steps Up Machine Efficiency and Reduces Operating Costs

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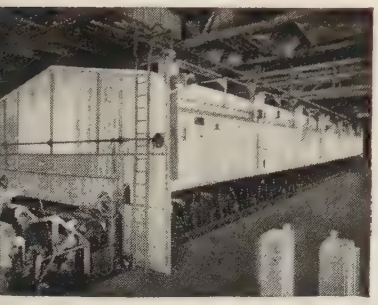


View of Ross-Hooper Hood with front lifting panels in closed or operating position.

Rear of Hood with sliding access doors closed.

Rear of Hood with sliding access doors open.

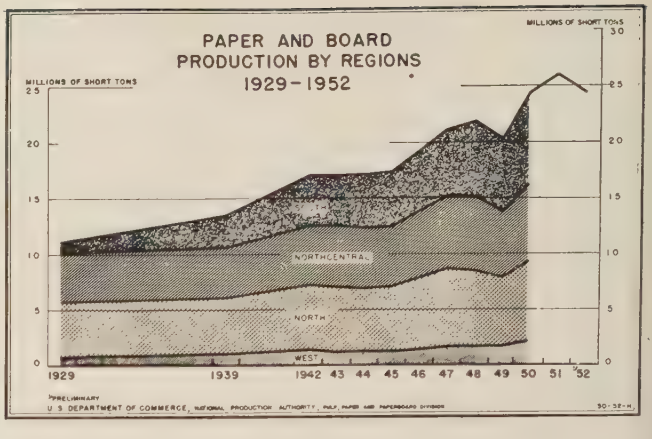
View of Dry End with lifting panels in operating position.

Production Workers and Wages, Pulp, Paper and Allied Products Industries

Year	Average number of wage earners, Thousands	Total dollar wages, Millions	Year	Average number of wage earners, Thousands	Total dollar wages, Millions
1899	94	36	1947	391	953
1909	145	68	1948	394	1063
1919	208	213	1949	382	1111
1929	233	287	1950	404	1284
1939	265	310	1951[a]	420	1436

[a] Preliminary.
Source: Bureau of Labor Statistics, Dept. of Labor. 1949 estimated on basis of monthly data furnished by Bureau of Labor Statistics.

example, the rapid trend on the West Coast in the last few years toward utilizing general logging debris, as well as sawmill waste has spread into the Lake States, the Northwest, as well as into the South. This development should see even greater progress during 1953 as new mechanical means of profitably using such otherwise waste wood are put into operation. Furthermore, a number of the new pulp mills, and others now under construction, will use increasing quantities of hardwoods which formerly were not considered suitable for pulping purposes. Several species of hardwoods are being used for chemical pulps but more particularly are finding their way into semichemical pulps. Greatly expanded semichemical pulp facilities over the past ten years, together with construction currently in progress, have been to a large degree for the manufacture of exceptionally high quality 0.009 corrugating medium having superior characteristics. One large mill in the Northeast expects to utilize large quantities of hardwood for newsprint, a product for which it was formerly thought only coniferous trees were suitable.



Imports of pulpwood, newsprint, wood pulp, and other paper and board products in 1952 totaled $925 million which represents almost one eighth of the total dollar value of domestic sales of the industry in this country. Exports, on the other hand, totaled $193 million, representing only about 2½% of the total value of the products of the industry.

The pulp and paper industry continues to be an important segment of our Nation's employment pattern. The latest figures available are for 1951 which disclose employment of 420,000 production workers with wages aggregating over $1.4 billion. It is not believed that there was much decline in employment or wages in 1952 even though there was a tapering off in production.

While a large part of the industry's products are sold to converters or manufacturers of other products for packaging and industrial purposes, or to large printers, nevertheless,

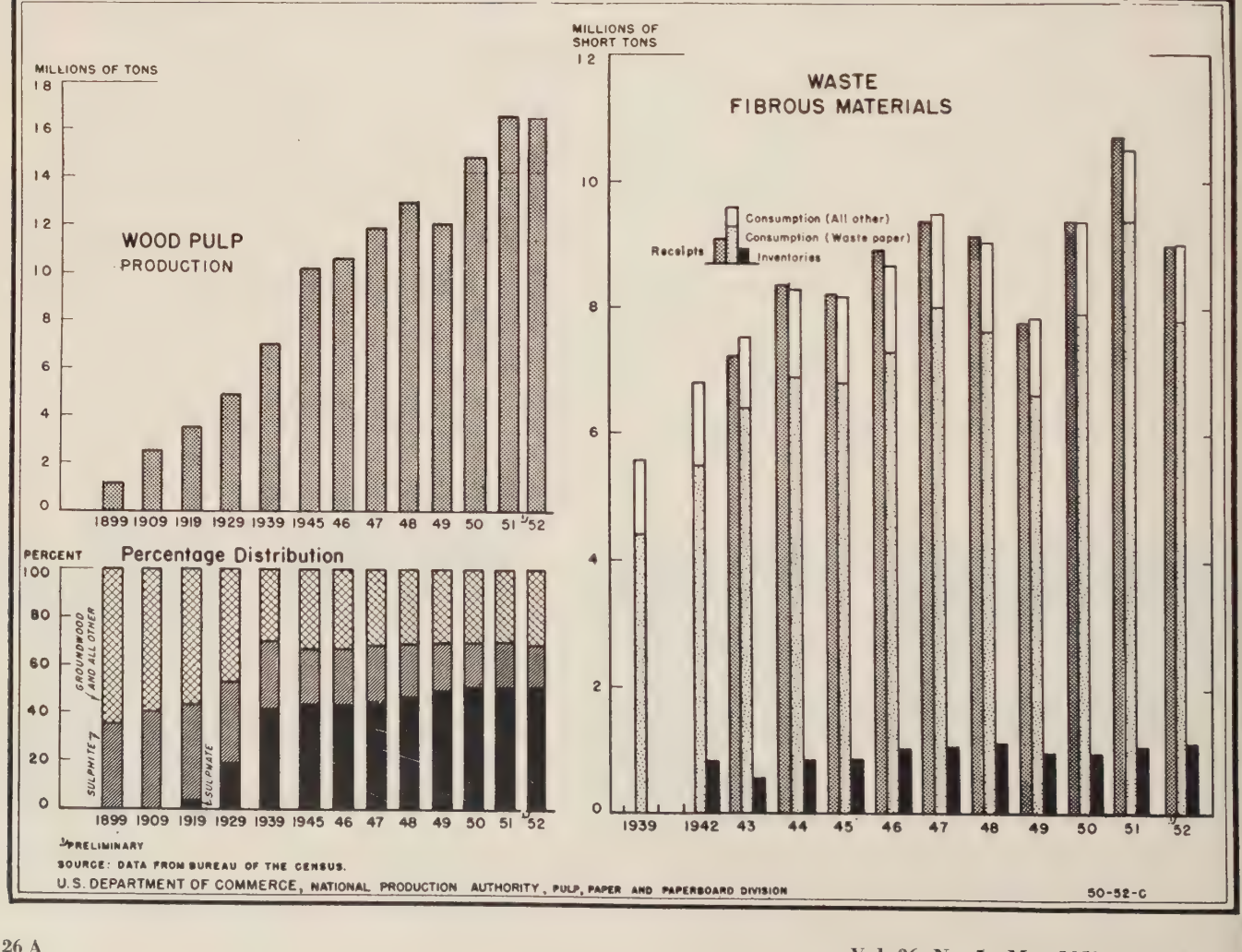


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Table X. Wood Pulp—United States Annual Production and Domestic Consumption in Paper and B

(1000 short tons)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942	1941
Production, total	16,467	16,524	14,849	12,207	12,872	11,946	10,607	10,167	10,108	9,680	10,783	10,375
Special alpha and dissolving	706	616	479	374	[b]	[b]	[b]	[b]		[b]	[b]	[b]
Sulphite, total[c]	2,367	2,525	2,370	2,162	2,811	2,796	2,476	2,360	2,386	2,437	2,930	2,919
Bleached[c]	1,692	1,761	1,629	1,455	1,909	1,902	1,692	1,544	1,523	1,553	1,717	1,703
Unbleached	675	764	741	707	902	894	784	816	863	883	1,213	1,216
Sulphate, total	8,569	8,572	7,502	5,977	6,014	5,357	4,588	4,472	4,549	4,236	4,738	4,527
Bleached	2,083	1,899	1,433	1,118	1,040	909	750	705	665	602	653	659
Semibleached	275	294	360	264	225	193	152	149	144	147	159	164
Unbleached	6,211	6,379	5,709	4,595	4,749	4,255	3,686	3,618	3,740	3,487	3,927	3,704
Soda	425	446	522	492	510	492	476	430	413	419	462	480
Groundwood	2,380	2,474	2,216	1,961	2,175	2,050	1,897	1,696	1,639	1,638	1,756	1,886
Defibrated, exploded, etc.	1,059	945	935	604				691	663	627	520	267
Semichemical	821	797	686	506	1,362	1,252	1,169					
Screenings, damaged, etc.	140	150	140	130				519	459	324	377	297
Consumption, total	17,274	17,737	16,509	13,636	14,375	13,252	12,092	10,825	10,502	10,635	11,038	11,364
Special alpha and dissolving	71	52	40	26	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
Sulphite, total[c]	2,971	3,240	3,276	2,986	3,333	3,229	3,144	2,583	2,519	2,892	3,079	3,348
Bleached[c]	1,944	2,037	2,029	1,825	1,856	1,792	1,680	1,346	1,277	1,442	1,498	1,805
Unbleached	1,027	1,203	1,247	1,161	1,477	1,437	1,465	1,237	1,242	1,449	1,581	1,543
Sulphate, total	9,131	9,310	8,381	6,678	6,663	5,860	5,141	4,680	4,588	4,430	4,633	4,614
Bleached	2,495	2,383	1,862	1,484	1,305	1,068	833	756	714	683	667	696
Semibleached	308	330	389	277	251	199	184	168	156	163	164	208
Unbleached	6,328	6,597	6,130	4,916	5,107	4,594	4,124	3,756	3,719	3,584	3,802	3,710
Soda	463	484	559	526	521	520	492	440	418	456	469	515
Groundwood	2,608	2,752	2,483	2,184	2,482	2,328	2,133	1,905	1,830	1,855	1,926	2,219
Defibrated, exploded, etc.	1,064	944	932	602	742			684	661	639	527	346
Semichemical	820	797	685	502	149	1,315	1,181					
Screenings, damaged, etc.	144	159	153	131	485			533	486	364	404	321

[a] Preliminary. [b] Included in "bleached sulphite" for 1941–48. [c] Includes "special alpha and dissolving" for 1941–48.

Note: Detail may not add to totals because of rounding.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from Bureau of the Census, U. S. Dept. of Commerce.

Table XI. Wood Pulp—Year-End Inventories, Pulp, Paper, and Board Mills Only, 1943–52

(1000 Short tons)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943
Wood pulp, total	711	611	492	512	710	710	490	555	333	427
Special alpha and dissolving	63	24	15	29	[b]	[b]	[b]	[b]	[b]	[b]
Sulphite, total[c]	256	239	193	238	370	369	232	299	196	256
Bleached[c]	120	112	86	100	157	163	107	127	152	184
Unbleached	136	127	107	138	213	206	125	173	44	72
Sulphate, total	298	231	197	147	226	244	176	179	66	67
Bleached	166	114	108	69	67	65	36	39	22	24
Semibleached	11	8	5	5	7	7	4	6	5	4
Unbleached	121	110	84	73	152	171	135	135	39	39
Soda	16	16	11	15	24	22	17	12	16	15
Groundwood	63	85	70	65	74	63	56	53	41	71
Miscellaneous	15	17	7	17	16	13	9	12	14	19

[a] Preliminary data for December 31, subject to revision. [b] Included in "bleached sulphite" for 1943–48. [c] Includes "special alpha and dissolving" for 1943–48.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from Bureau of the Census, U. S. Dept. of Commerce (figures for 1945–48); Forest Products Bureau, WPB (figures for 1943–44).

Table XII. Dissolving and Special Chemical Grades of Pulp[a] in Other Than Paper and Board Manufacture[b] 12 Months 1952–51

(Tons of 2000 Lb.)

Month	Receipts			Consumption	Month-end Inventories
	Total	Domestic	Imports from North America[c]		
January	64,884	46,233	18,651	63,021	80,116
February	63,211	44,977	18,234	58,831	83,806
March	59,404	44,434	14,970	58,521	84,689
April	54,553	38,302	16,251	51,700	87,475
May	59,859	44,386	15,473	54,244	93,100
June	52,164	38,539	13,625	56,238	89,013
July	61,628	44,191	17,437	63,290	87,211
August	74,562	53,545	21,017	69,976	91,904
September	70,248	51,099	19,149	70,614	91,538
October	75,302	51,600	23,702	73,625	93,214
November	75,029	52,264	22,765	65,947	102,302
December	70,367	48,198	22,169	66,040	106,629
Total, 1952	781,211	557,768	223,443	752,037	106,629
Total, 1951	730,709	488,438	242,271	713,840	77,831

[a] Includes a small quantity of most other grades of wood pulp. [b] Includes plants classified in the following industries: "Pulp goods, pressed and molded, "Plastic materials," "Synthetic fibers," and "Explosives." [c] Includes a small quantity of wood pulp, produced outside North America.

Source: Forest Products Division—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census, . S. Department of Commerce.

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Table XIII. Market Wood Pulp[a]—Paper and Paperboard Mills Only—Annual Receipts, Consumption, and Inventories 1947–52

(1000 Short Tons)

Item	1952	1951	1950	1949	1948	1947
Wood pulp, total all grades:						
Receipts, total	2279	2819	2916	2152	2571	2709
Domestic	1123	1297	1213	938	1060	1189
Imported	1156	1522	1703	1214	1511	1520
Canada and Newfoundland	846	1054	976	707	917	784
European	310	468	727	507	594	736
Consumption (purchased pulp) total	2252	2742	2902	2325	2586	2511
Inventories (purchased pulp) total[b]	404	395	332	342	519	532
Domestic shipments, total[c]	1074	1254	1147	905	1024	1041
Sulphite, all grades:[d]						
Receipts, total	1143	1398	1466	1209	1474	1554
Domestic	599	702	672	588	649	722
Imported	544	696	794	621	825	832
Canada and Newfoundland	402	498	480	370	525	492
European	142	198	314	251	300	340
Consumption, total	1110	1362	1484	1313	1455	1432
Inventories, total[b]	213	202	163	194	297	283
Domestic shipments[c]	561	720	655	576	642	655
Sulphate, all grades:						
Receipts, total	775	947	1003	614	714	780
Domestic	351	398	325	187	200	260
Imported	424	549	678	427	514	520
Canada and Newfoundland	281	318	301	208	236	154
European	143	231	377	219	278	366
Consumption, total	769	919	973	666	720	730
Inventories, total[b]	140	141	120	102	158	188
Domestic shipments[c]	357	362	291	181	199	200
Groundwood and other grades:						
Receipts, total	361	474	445	329	383	375
Domestic	173	197	216	163	211	207
Imported	188	277	229	166	172	168
Canada and Newfoundland	163	238	187	129	156	138
European	25	39	42	37	16	30
Consumption, total	373	461	442	346	411	349
Inventories, total[b]	51	52	49	46	64	61
Domestic shipments[c]	156	172	201	148	183	186

[a] Market pulp consists of domestic or imported pulp purchased from a mill not under the same ownership control as the purchaser. [b] End of year. [c] Shipments by domestic pulp mills to domestic paper and paperboard mills. The difference between shipments and receipts may be explained in part by "in transit" pulp and probable incomplete reports on domestic shipments. [d] Includes "special alpha and dissolving."

Note: Data on imports from Canada and Newfoundland also include shipments from all other North American countries, such as Mexico; data on imports from Europe also include shipments from all overseas sources.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from Bureau of the Census, U. S. Dept. of Commerce. Data for 1952 preliminary.

in 1952, $2.2 billion of paper and products were handled by wholesale paper merchants throughout the United States. In other words, approximately 25% of the products of the industry in terms of value are distributed by wholesale paper firms.

PULPWOOD

The growth in United States pulpwood consumption has been consistent and particularly rapid over the past 15 years. Consumption of 26.4 million cords in 1952 compares with only 10.8 million in 1939. The pulp industry represents the only major industry consuming timber supplies which has shown a marked upward growth during the past decade. This factor has stimulated the intensive forestry and conservation practices being developed by the industry.

The pulpwood statistics reveal the trend in wood pulp production by regions for 1952 which are not available from any other source. It may be observed that in the South and in the Pacific Northwest pulpwood consumption in 1952 exceeded that of 1951, thereby indicating an upward trend in pulp production in those two regions. On the other hand, pulpwood consumption in the Northeast, Appalachian, and Lake State regions declined somewhat in 1952 below 1951.

It is also apparent that pulpwood inventories at the end of 1952 were still high in the Northeast and Lake States which is the primary reason that pulp mills in those areas slackened

Table XIV. Waste Fibrous Materials—United States Annual Receipts, Consumption, and Inventories

(1000 Short Tons)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944[b]	1943[b]	1939
Receipts, total	9029	10,707	9399	7759	9120	9434	8895	8194	8359	7224	[c]
Wastepaper	7813	9,252	7964	6522	7605	7875	7487	6824	6937	6067	[c]
Rags	320	396	440	378	407	445	427	392	431	404	[c]
Other	896	1,059	995	859	1108	1114	981	978	991	753	[c]
Consumption, total	9077	10,515	9395	7815	9036	9535	8661	8143	8244	7564	5526
Wastepaper	7881	9,071	7956	6600	7584	8009	7278	6800	6859	6368	4366
Rags	325	389	442	382	416	462	403	414	428	426	468
Other	871	1,055	997	833	1036	1064	980	929	957	770	692
Inventories, total	1095	1,171	966	998	1129	1087	1078	840	837	533	[c]
Wastepaper	522	589	387	397	517	521	515	327	315	249	[c]
Rags	54	61	54	56	58	67	77	53	79	71	[c]
Other	519	521	525	545	554	499	486	460	443	213	[c]

[a] Preliminary. [b] 1944 receipts and inventories and data for 1943 were reported by a few mills other than paper and paperboard mills. Data for the remaining years are for paper and paperboard mills only. [c] Not available.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority; based upon data from the Bureau of the Census, U. S. Dept. of Commerce, and Forest Products Bureau, War Production Board.

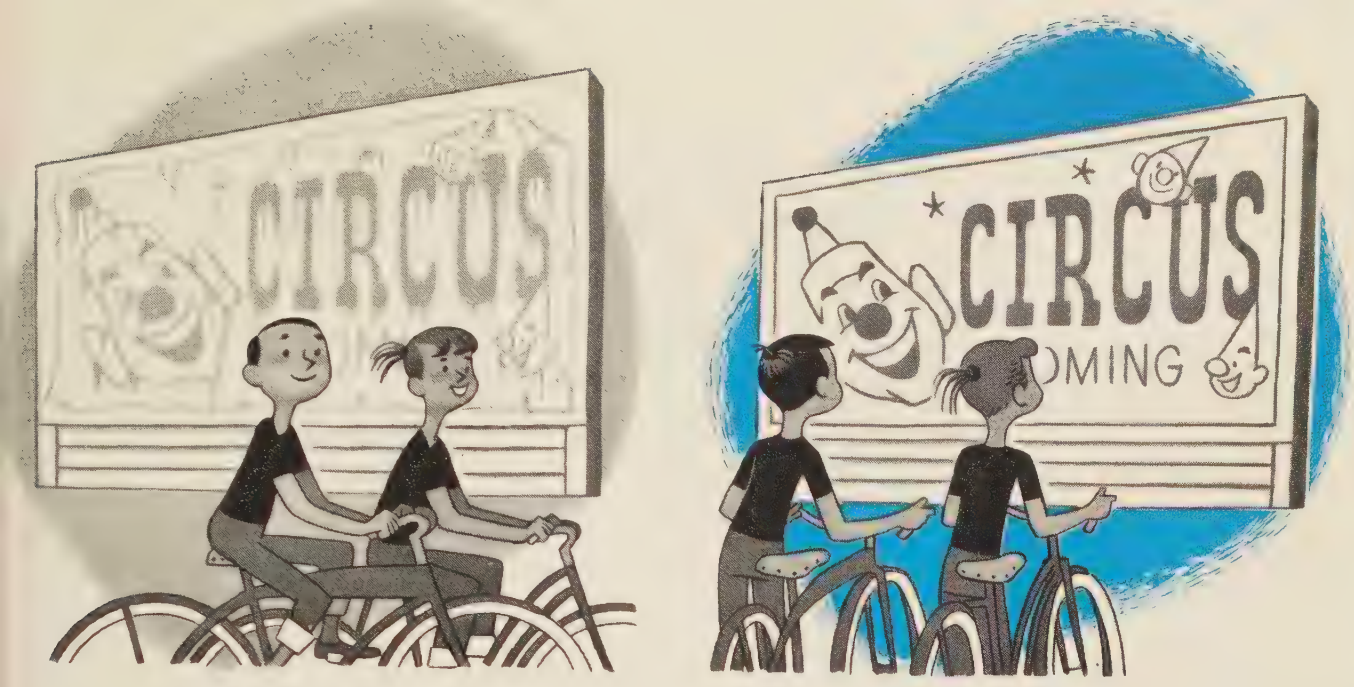

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Table XV. Paper and Paperboard—United States Production, 1942–52

(1000 Short tons)

Type of product	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
All types	24,413	26,048	24,375	20,316	21,897	21,114	19,278	17,371	17,183	17,036	17,084
Paper, total	12,194	13,011	12,064	10,349	11,119	10,705	9,788	8,457	8,220	8,416	9,115
Newsprint	1,106	1,108	1,013	918	876	833	773	725	721	811	967
Groundwood	809	791	705	674	772	821	776	636	593	586	610
Printing	592	519	488	484	538	546	474	351	314	356	341
Converting and other	217	172	217	190	234	275	302	285	279	230	269
Machine coated paper	1,096	1,113	1,020	887	809	627	486	334	305	308	322
Book paper	1,482	1,610	1,579	1,416	1,570	1,581	1,447	1,167	1,131	1,285	1,382
General printing	954	1,035	1,008	926	1,067	1,070	972	777	729	841	868
Converting	517	558	557	476	485	498	457	380	400	437	507
Other book paper	11	18	14	14	18	13	18	10	2	7	7
Fine paper	1,295	1,366	1,199	1,015	1,141	1,172	1,160	1,001	974	1,021	1,055
Writing paper	1,052	1,093	958	806	909	918	902	811	777	814	832
Rag	134	161	138	120	138	174	176	191	118	117	123
Chemical wood	918	932	820	686	771	744	726	620	659	697	709
Cover and text	59	63	61	63	72	93	93	59	52	48	46
Bristols	106	109	102	79	88	87	97	67	84	99	109
Thin paper[b]	78	101	78	67	72	73	68	63	61	59	68
Coarse paper, total	3,235	3,627	3,298	2,758	3,027	2,903	2,690	2,403	2,314	2,262	2,526
Glassine, greaseproof and vegetable parchment	138	177	162	141	151	156	158	140	139	144	135
Wrapping	651	705	713	692	726	667	763	715	650	687	955
Bag paper	797	838	754	690	736	540	524	365	375	518	661
Shipping sack	753	849	748	510	567	671	550	423	392	315	251
Converting	896	1,057	921	725	847	869	695	760	758	597	526
Special industrial paper	396	408	341	248	308	289	272	238	245	208	188
Sanitary paper	1,148	1,244	1,148	1,008	983	894	861	824	808	806	811
Tissue paper	209	229	217	187	205	195	184	157	158	163	171
Absorbent paper	118	128	119	86	107	100	103	89	90	88	65
Building paper and insulation	1,298	1,386	1,425	1,151	1,321	1,289	1,036	883	881	878	1,017[c]
Board, all types, total	12,220	13,037	12,311	9,967	10,778	10,409	9,490	8,914	8,963	8,620	7,969
Container board	5,770	6,323	5,830	4,680	5,079	4,944	4,315	4,141	4,228	4,088	3,755
Folding boxboard	2,193	2,362	2,352	1,943	2,024	2,257	2,317	2,092	2,116[d]	2,047[d]	1,712[d]
Setup boxboard	687	733	712	617	596	595	521	721	750	829	997
Cardboard	69	85	87	83	87	92	89	71	70	64	54
Building board	1,305	1,269	1,220	839	1,270	1,072	956	895	1,087[e]	1,064[e]	1,052[e]
Wet machine board	137	148	166	131	142	150	138	112	130	121	86
Other board	2,056	2,116	1,944	1,674	1,580	1,300	1,154	891	581	408	313

[a] Preliminary. [b] Includes small amounts of "other fine papers." [c] Includes 16 M tons of "other paper." [d] Includes all grades of bending board. [e] Includes liner for gypsum and stock for laminated wallboard.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from Bureau of the Census, U. S. Dept. of Commerce.

their procurement programs for the past Winter's pulpwood logging activities. These mills, however, are doing everything possible to maintain amiable relations with their normal pulpwood suppliers, especially small operators and farmers, so as to be able to maintain a suitable flow of pulpwood in future years.

WOOD PULP

Both wood pulp production and consumption have disclosed a phenomenal growth over the past decade, having more than doubled since 1939.

The largest growth in pulp has been in the sulphate field with 1952 production amounting to 8.6 million tons compared with only 4.7 million tons in 1942. While comparable statistics are not available for earlier years, there has also been a very marked upward trend in the production of special alpha and dissolving pulp, as well as in semichemical and defibrated pulps. Similar trends in consumption of these grades of pulp are evident. It should be noted that the principal field of consumption for dissolving and special chemical grades of pulp is in the field of synthetic fiber, cellophane, plastics, etc., although relatively small tonnages amounting to about 70,000 tons of these grades were used in the manufacture of paper in 1952. Of the total consumption of dissolving grades in nonpaper manufacture amounting to 752,000 tons in 1952, approximately 223,000 tons originated in Canada.

As previously noted, the trend in purchased (market) wood pulp consumed by paper and board mills in 1952 was downward. The largest percentage decline was in imports from Europe, although there was also a noticeable tonnage decline in

Table XVI. Newsprint—United States Production, Imports, Exports, Domestic Consumption, and Inventories

(1000 Short Tons)

Item	1952[a]	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
Production	1106	1108	1013	918	876	833	773	725	721	811	967
Imports	5033	4963	4863	4639	4395	3958	3492	2669	2491	2637	2921
Re-exports[b]	n.a.	n.a.	n.a.	5	2	2	2	3	9	2	2
Exports	105	71	44	39	28	28	28	44	31	35	42
Total supply	6034	6000	5832	5513	5241	4761	4235	3347	3172	3411	3845
Inventories, total	624	530	433	457	467	386	308	273	350	378	489
Publishers[c]	612	522	425	466	458	377	293	266	342	367	479
Mill	12	8	8	11	9	9	15	6	7	11	10
Change in stocks	+94	+97	−24	−10	+81	+78	+35	−77	−28	−112	+96
Apparent consumption	5940	5903	5856	5523	5160	4683	4200	3424	3200	3523	3749

[a] Preliminary. [b] Re-exports of newsprint included in the general import statistics. [c] Reported by 422 publishers of 525 newspapers consuming approximately 76% in 1952; 75.5% in 1951; 76.5% in 1950; 77% in 1949; 78% in 1948; and 75% in 1947; 73% in 1946; 70% in the first half and 71% in second half of 1945; 72.5% in 1944; and 75% in 1943.

n.a.—Not available.

Source: Production, import, and export figures, Bureau of the Census, U. S. Dept. of Commerce; publishers' inventories, American Newspaper Publishers' Association; mill inventories, News Print Service Bureau; consumption equals supply adjusted for change in stocks.

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May 1953 Vol. 36, No. 5

Table XVII. Production of Newsprint in North America

(1000 Short Tons)

Year	Total[a]	United States	Canada	Newfoundland
1952[b]	6793	1106	5687	[c]
1951	6624	1108	5516	[c]
1950	6292	1013	5279	[c]
1949	6092	918	4732	444
1948	5859	876	4601	382
1947	5653	833	4447	373
1946	5279	773	4143	363
1945	4317	725	3259	333
1944	3985	721	2992	273
1943	4030	811	2983	236
1942	4422	967	3177	277
1941	4815	1044	3426	345
1940	4826	1056	3419	351
1939	4129	954	2869	305

[a] Details may not add to total because of rounding. [b] Preliminary. [c] Data for Canada include figures for Newfoundland.

Source: United States, Bureau of the Census, U. S. Dept. of Commerce; Canada and Newfoundland, Newsprint Association of Canada.

receipts of both domestic and Canadian market pulp. Year-end inventories of market pulp amounting to approximately two months' supply were slightly higher than at the end of 1951. In view of the higher level of paper and board production in the first part of 1953 it is anticipated that demand for market pulp will return to higher levels and, furthermore, that there may be some incentive for such mills to further strengthen their inventory position.

WASTE FIBROUS MATERIALS

In the field of waste fibrous materials there has been an upward trend in consumption, but not to the same degree as in the production or consumption of wood pulp or in the production of the various grades of paper and paperboard. The principal material in this area is wastepaper. It is evident that with the current annual consumption of around

Table XVIII. Newsprint—United States Imports by Country of Origin

(1000 Short Tons)

Source	1952[a]	1951	1950	1949	1948	1947	1946
Total[b]	5033	4963	4863	4639	4395	3958	3492
Canada[c]	4850	4756	4690	4382	4127	3829	3478
Finland	162	160	144	151	132	84	12
Sweden	16	30	18	37	70	25	1
United Kingdom	..	..	[d]	35	3	..	..
Norway	4	9	4	30	28	6	.
France	..	5	2	2	28	10	..
All other countries	1	3	2	1	7	4	..

[a] Preliminary. [b] Data do not necessarily add to total because of rounding. [c] Includes Newfoundland. [d] Less than 500 short tons.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census, U. S. Dept. of Commerce.

Table XIX. Monthly Value of Sales by United States Pulp, Paper, Board, and Products Manufacturers, 1947–52 (Unadjusted)

(Millions of Dollars)

Month	1952[a]	1951	1950	1949	1948	1947
January	709	712	478	458	504	458
February	668	684	472	432	489	449
March	688	772	541	476	532	469
April	660	739	493	438	516	482
May	655	771	530	422	500	494
June	635	728	544	432	520	474
July	602	622	493	372	456	431
August	667	720	615	462	519	479
September	676	666	585	490	521	503
October	750	733	646	506	532	547
November	665	681	643	497	498	482
December	648	604	631	463	473	496
Total	8023	8432	6671	5448	6060	5764

[a] Preliminary.

Source: Office of Business Economics The estimated dollar total of sales represents receipts of all operators of paper manufacturing companies. The figures include data for both corporate and noncorporate businesses, but are comparable to the sales data for corporations in Statistics of income published by the Bureau of Internal Revenue.

Table XX. Wholesale Price Index Numbers for Selected Subgroups and Classes of Wood Pulp, Paper, Paperboard, and Converted Products and Other Selected Commodity Groups

(Index 1947–49 = 100)

Item	1952[a]	1951	1950	1949	1948	1947
All commodities other than farm and foods	113.0	115.9	105.0	101.3	103.4	95.3
Pulp, paper, and products group	116.6	119.6	100.9	98.5	102.9	98.6
Wood pulp subgroup	111.5	114.4	95.6	97.0	107.3	95.6
Sulphate, Southern, unbleached	109.9	120.7	88.5	89.2	112.6	98.2
Sulphate, bleached	107.9	116.3	93.9	101.5	119.1	79.5
Sulphite, bleached	112.0	112.0	98.1	98.7	104.2	97.1
Mechanical	118.1	122.1	89.6	91.5	106.7	101.8
Soda, bleached	112.9	112.9	96.5	97.9	106.1	96.0
Wastepaper subgroup	70.1	188.2	119.5	61.3	90.4	148.3
Books and magazines	110.2	295.9	114.4	71.7	90.7	137.6
Folded news	67.2	148.8	114.6	65.7	91.0	143.3
Mixed paper	56.6	193.9	128.3	48.8	84.1	167.1
Corrugated	61.4	207.3	119.5	61.2	93.8	144.9
Paper subgroup	124.0	119.1	106.5	103.8	102.8	93.4
Paper, except newsprint class	123.5	110.4	106.5	103.3	103.1	93.7
Hanging	125.1	119.6	104.5	105.4	105.1	89.5
Printing paper	117.0	120.7	102.7	102.2	101.3	96.4
Bookpaper	125.8	119.8	108.5	105.2	100.7	94.1
Wood bond	117.8	115.7	105.2	103.1	104.4	92.6
Writing paper	127.1	125.1	110.5	101.4	102.3	96.4
Wrapping paper	124.5	122.3	106.7	103.1	104.8	92.1
Butcher's paper	128.1	126.8	108.5	102.7	103.2	94.1
Waxing paper	124.4	222.7	103.9	102.4	105.1	92.6
Wrapping tissue	122.8	132.2	100.0	99.4	104.9	95.7
Newsprint class	125.7	115.4	106.2	105.5	101.9	92.6
Paperboard subgroup	127.4	131.8	105.0	98.8	102.0	99.2
Container board class	115.6	117.8	102.8	100.5	100.1	99.4
Folding boxboard class	144.8	150.0	109.7	99.4	103.0	97.5
Setup boxboard class	128.1	135.9	103.1	94.3	104.5	101.3
Converted products subgroup	113.8	116.9	97.7	97.1	102.4	100.5
Building paper and board subgroup	115.3	113.4	107.6	104.2	102.8	93.0
Fuel and power group	106.6	106.7	103.0	101.9	107.1	90.9
Chemicals and allied products group	104.5	110.1	96.3	94.8	103.8	101.4

[a] Preliminary.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, Dept. of Commerce, based upon data supplied by the Bureau of Labor Statistics, U. S. Dept. of Labor.

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PAPER AND PAPERBOARD

The inventory cycle of 1951 and 1952 had a very important bearing on the level of production in these two years with the result that for practically all grades of paper and paperboard the 1952 output was less than in 1951. Only two grade groups did not follow this pattern, namely groundwood printing papers and building boards.

Newsprint production in the United States in 1952 remained almost identical to that in 1951. Imports, on the other hand, increased about 75,000 tons. Consumption of newsprint for 1952 was only about 40,000 tons greater than the year previous while inventories were enlarged.

EXPORT TRADE

United States exports of pulp and paper products in 1952 were at a fairly high level. In fact, wood pulp exports were larger than in any year since 1944 and totaled 212,000 tons. Likewise paper exports in 1952 totaling 326,000 tons were at a high level and apparently established an all-time record. An important part of the increase in paper exports in 1952 was accounted for by a gain in newsprint exports of about 25,000 tons over 1951. Newsprint exports in 1952 totaled 105,000 tons. In earlier years newsprint exports ran between 5000 and 40,000 tons a year. Other notable gains were in kraft shipping sack paper, wallboard, and in uncoated book papers. Declines were registered in many other grades.

Paperboard exports in 1952 amounted to 173,000 tons, a large decline from 1951, particularly in the container board and boxboard categories.

In the area of paper products, 1952 exports also declined

Table XXI. United States Exports of Pulpwood, Wood Pulp, Paper, Paperboard, and Paper Products

(In Short Tons Except Where Otherwise Indicated)

Item	1952[a]	1951	1950	1949	1948	1947
Pulpwood (in cords of 128 cu. ft.)	16,819	13,074	27,053	7,689	38,650	79,273
Wood pulp, total	211,623	199,708	95,673	122,133	93,727	130,096
Bleached sulphite: rayon and special chemical grades	65,233	31,157	27,634	25,493	17,982	10,688
Bleached sulphite: other	23,683	44,165	18,364	19,770	13,228	43,546
Unbleached sulphite	34,548	43,672	32,836	39,383	53,690	53,857
Bleached sulphate	11,604	9,488	4,709	9,542	716	2,187
Unbleached sulphate	75,563	68,464	9,555	27,234	6,115	17,332
Soda, screenings, and other wood pulp	992	2,762	2,575	711	1,996	2,486
Waste fibrous materials, total	153,199	216,715	126,874	125,308	169,682	163,106
Overissue news	79,710	102,383	68,495	74,265	23,080	30,883
Rags for paper stock	8,384	10,277	7,173	8,111	12,355	12,061
Other wastepaper and paper stock	65,105	104,055	51,206	42,932	134,247	120,162
Paper, paperboard, and paper products, total	591,338	635,303	371,546	372,277	397,019	474,486
Paper and paperboard, total	498,111	527,897	297,182	294,860	295,133	352,403
Paper, total	325,576[b]	277,164[b]	175,157[c]	181,035[c]	161,388	213,933
Newsprint	104,998	71,295	43,966	38,660	27,662	27,890
Book paper, uncoated	48,164	33,851	20,123	28,230	44,442	54,290
Fine paper, total	40,446[d]	47,776[d]	38,535[d]	43,656[d]	45,317	68,302
Writing paper	32,128	35,246	29,801	32,901	29,942	46,881
Cover paper	921	810	547	[e]	1,261	3,104
Bristols	910	1,409	1,071	1,034	5,197	6,051
Cigarette paper	5,501	8,790	6,580	8,327	8,917	12,266
Wrapping, bag and converting paper, total	88,394	76,506	39,892	28,062	28,589	41,398
Kraft, including shipping sack paper	77,681	60,792	28,563	17,652	10,925	12,554
Greaseproof and waterproof paper[f]	2,857	5,489	3,843	3,297	8,500	13,735
Other paper	7,856	10,225	7,486	7,113	9,164	15,109
Tissue and crepe paper[g]	5,288	7,294	7,433	10,029	4,927	8,428
Blotting paper	2,611	2,854	2,735	2,761	2,644	4,640
Sheathing and building paper	7,828	10,015	8,321	9,218	7,807	8,985
Paperboard, total	172,535[h]	250,733[h]	122,025[h]	113,825[h]	133,745	138,470
Container board (liners and corrugating)	92,232	134,613	59,940	49,900	49,991	47,866
Boxboard (bending and nonbending)	23,129	50,040	14,944	20,105	12,445	12,011
Other paperboard	32,890	41,121	23,678	19,269	35,712	37,497
Fiber insulation board	16,063	20,210	15,700	18,872	18,053	27,789
Wallboard	8,221	4,749	7,763	5,679	17,544	13,307
Paper products, total	93,227	107,406	74,364	77,417	101,886	122,083
Surface-coated paper	[e]	[e]	[e]	[e]	12,509	22,091
Toilet paper	7,954	9,406	7,383	8,046	7,284	7,686
Paper towels and napkins	2,764	2,736	1,972	1,867	1,908	2,042
Filing folders, index cards, and other office forms	3,483	3,699	3,772	2,636	1,934	1,756
Papeteries	[e]	407	359	366	56	411
Wallpaper	292	258	206	205	91	636
Shipping sacks	12,986	19,803	10,128	5,716	22,826	21,459
Paper bags	5,247	6,462	7,101	10,293	6,898	9,630
Shipping containers	15,344	14,867	7,795	9,822	9,030	9,548
Boxes and cartons	10,021	9,688	5,247	5,365	5,200	6,988
Envelopes	551	525	502	700	865	1,206
Cash register and adding machine paper	[e]	[e]	[e]	[e]	4,114	4,459
Other paper and paper products	34,585	39,555	29,899	32,401	29,171	34,171

[a] Preliminary. [b] Includes special industrial and coated printing and converting paper. [c] Includes 7297 tons of uncoated and paper machine-coated paper. [d] Includes small quantity of miscellaneous thin paper and other paper not shown separately. [e] Not shown separately. [f] Includes cellophane, glassine, vegetable parchment, etc. [g] Includes thin paper, other than cigarette and sanitary paper, except toilet paper. [h] Total board including paperboard, building board, and wet machine board.

Conversion factors derived from reported gross shipping weights: fiber insulation board—1 sq. ft. = 0.87 lb.; wallboard—1 sq. ft. = 0.65 lb.; wallpaper—1 roll = 1.04 lb.; other paper and paper products— $380 = 1 ton.

Source: Prepared by the Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census U. S. Dept. of Commerce.

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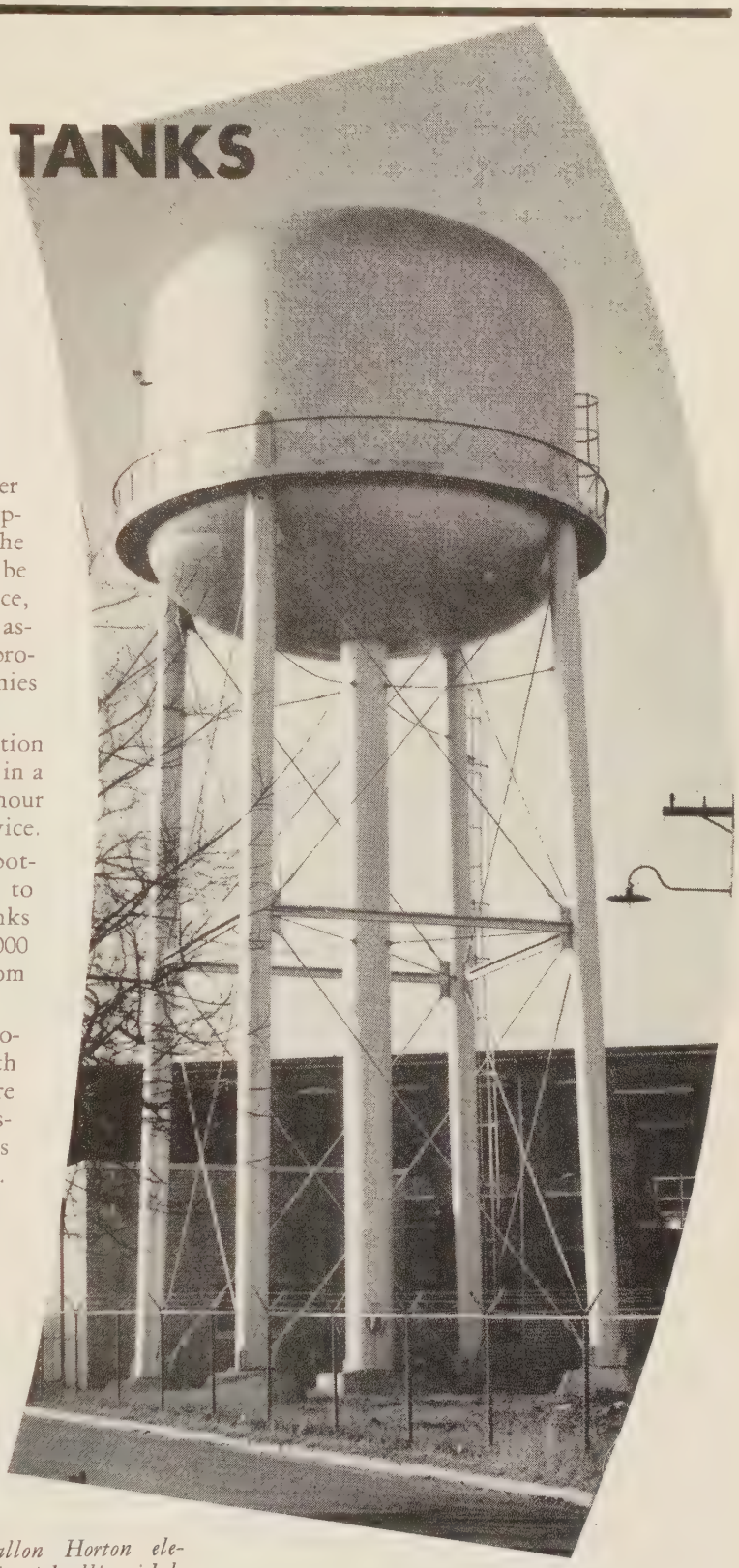

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Table XXII. United States Imports of Pulpwood, Wood Pulp, Paper, Paperboard, and Paper Products

(In Short Tons, Except Where Otherwise Indicated)

Item	1952[a]	1951	1950	1949	1948	1947
Pulpwood, total (in cords of 128 cu. ft.)	2,124,880	2,511,401	1,412,365	1,418,468	2,020,979	1,828,228
Rough	820,275	883,390	373,460	510,134	913,838	936,293
Peeled	1,036,959	1,406,937	884,781	791,325	1,010,993	820,359
Rossed	3,142	3,931	151	447	806	730
Chipped	264,504	217,143	153,973	116,562	95,342	70,846
Wood pulp, total	1,936,687	2,360,734	2,384,975	1,763,102	2,176,111	2,322,460
Bleached sulphite: Rayon and special chemical grades	222,608	230,800	238,846	153,946	235,481	248,606
Bleached sulphite: other	276,698	348,541	401,776	331,288	322,830	288,559
Unbleached sulphite	431,678	557,357	528,673	392,222	674,707	731,648
Bleached sulphate	519,035	521,560	450,352	391,609	277,989	239,069
Unbleached sulphate	207,871	335,573	440,378	248,814	336,449	470,174
Soda pulp	28,073	33,373	33,947	27,315	24,843	21,203
Chemical screenings	4,260	10,344	4,695	3,163	8,275	9,552
Bleached mechanical groundwood	34,341	17,675	20,202	593	.....	.....
Unbleached mechanical groundwood	207,899	300,418	260,347	208,224	290,984	308,946
Mechanical groundwood screenings	4,224	5,093	5,759	5,928	4,553	4,703
Waste fibrous materials, total	78,872	110,710	131,282	72,055	102,845	80,924
Rags for paper stock	78,655	110,600	131,194	7,917	20,040	13,772
Other pulp—rag, straw, esparto, etc.	.....	.....	[b]	[b]	4	31
Other waste fibrous materials	217	110	88	64,138	82,801	67,121
Paper, paperboard, and paper products, total	5,191,126	5,152,322	5,007,384	4,751,323	4,581,811	4,121,400
Paper and paperboard, total	5,173,352	5,139,254	4,998,347	4,746,248	4,575,095	4,115,968
Paper, total	5,098,593	5,024,870	4,912,974	4,676,126	4,499,682	4,057,110
Newsprint	5,033,014	4,962,562	4,862,995	4,639,562	4,395,572	3,957,833
Printing paper, uncoated	42,984	47,326	35,278	28,281	83,379	74,401
Fine paper, total	1,314	1,333	1,229	640	1,537	1,579
Writing paper	79	74	115	37	120	92
Cover paper	.....	[b]	[b]	[b]	3	.....
Bristols	156	258	259	93	12	3
Thin paper	952	799	710	419	1,344	1,408
Other fine paper	127	202	145	91	58	76
Wrapping, bag, and converting paper, total	10,331	11,079	10,864	5,712	18,420	22,621
Kraft wrapping[c]	8,656	6,876	7,330	3,823	10,628	10,936
Greaseproof and waterproof paper	564	2,130	1,148	22	48	79
Wrapping, except kraft[c]	1,111	2,073	2,386	1,867	7,744	11,606
Tissue and crepe paper	266	223	452	1,352	376	32
Absorbent paper	129	94	101	122	92	76
Building paper	1,555	2,253	2,055	457	306	568
Paperboard, total	83,759	114,384	85,373	70,122	75,413	58,858
Kraft container board	4,385	967	.....	.....	.....	.....
Other container and boxboard	175	1,739	465	3	629	2,221
Other paperboard	52,419	78,416	54,179	47,769	44,015	23,852
Fiber insulation board	3,824	3,015	3,319	275	400	1,283
Wallboard	22,956	30,247	27,410	22,075	30,369	31,502
Paper products, total	17,774	13,068	9,037	5,075	6,716	5,432
Papeteries	219	133	155	73	38	50
Surface-coated papers	2,404	1,002	265	40	32	33
Uncoated papers, decorated or covered with a design, etc.	78	103	25	1	7	5
Wallpaper	2,879	2,303	2,638	1,365	1,259	1,436
Decalcomania paper	608	1,277	1,110	619	957	922
Boxes of paper, papier-mâché, or paperboard (not covered or lined)	1,119	543	479	357	300	247
Boxes of paper, papier-mâché, or wood (covered or lined)	204	96	67	41	27	18
Manufacturers of papier-mâché, n.s.p.f.	163	154	106	58	51	21
Manufacturers of pulp, n.s.p.f.	78	268	96	51	52	65
Bags and articles of surface-coated, parchment, or similar papers	229	181	168	56	63	77
Albums, photograph, autograph, scrap, etc.	4	2	6	2	3	2
Envelopes	182	126	47	47	40	24
Jacquard designs	.....	.....	[b]	[b]	.....	[b]
Gummed paper, n.s.p.f.	9	211	19	[b]	1	2
Tubes for holding yarn and thread	54	69	22	[b]	.....	[b]
Wall pockets of paper, papier-mâché, etc.	28	38	37	3	1	.....
Ribbon flycatchers	83	44	115	.....	9	103
Masks of paper, pulp or papier-mâché	30	31	8	6	.....	1
Reinforced or cloth-lined paper	[b]	[b]	[b]	[b]	.....	.....
Stencil paper, not mounted	[b]	4	2	1	1	[b]
Papers, n.s.p.f.	2,185	1,729	1,133	400	652	975
Manufacturers of paper, n.e.s.	7,218	4,754	2,539	1,955	3,223	1,451

[a] Preliminary. [b] Less than one-half short ton. [c] Includes bag paper. Conversion factors derived from reported gross shipping weights. Stereotype matrix mat or board (included under absorbent paper)—1000 sq. in. = 1.43 lb.; papeteries —$500 = 1 ton. Boxes of paper, papier-mâché, or paperboard (not covered or lined) $140 = 1 ton. Manufacturers of papier-mâché, n.s.p.f.—$2240 = 1 ton. Manufacturers of pulp, n.s.p.f.—$860 = 1 ton. Albums, photograph, autograph, scrap, etc.—$3060 = 1 ton. Jacquard designs on ruled paper, etc.—$94,000 = 1 ton (price includes cost of die). Ribbon flycatchers—$840 = 1 ton. Masks of paper, pulp, etc.—$760 = 1 ton. Papers, n.s.p.f.—$80 = 1 ton. Manufacturers of paper, n.e.s.—$360 = 1 ton. Wall pockets of paper, papier-mâché, etc.—10,000 wall pockets = 1 ton.

Source: Prepared by the Forests Products Div.—Pulp, Paper, and Paperboard, National Production Authority, based upon data from the Bureau of the Census, U. S. Dept. of Commerce.

Is there an Atlantic wax for butter cartons?

Yes. There's an Atlantic wax for every use

If you've ever tried to "make do" with a wax not fitted for your application, you know some of the troubles that can result . . . and how much money it may cost you in the end. But you can eliminate those problems, easily and economically, by selecting your wax from the broad Atlantic line.

Atlantic waxes are available in a wide range of hardnesses with melting points from 123° to 148° F —all fully refined. Let our engineering specialists help you make the right selection. Their ready assistance and special knowledge of wax application problems can help assure you the most satisfactory results and the greatest real economy.

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- ☐ Bread wrappers
- ☐ Building papers
- ☐ Butcher's paper
- ☐ Candles
- ☐ Candy wrappers
- ☐ Cartons, butter
- ☐ Cartons, frozen food
- ☐ Cartons, ice cream
- ☐ Chewing gum
- ☐ Crayons
- ☐ Drinking cups
- ☐ Electric insulation coating
- ☐ Fabric sizing
- ☐ Fiber plates
- ☐ Florist paper
- ☐ Fruit wrappers
- ☐ Glassine paper
- ☐ Kitchen rolls
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in total, although there was a small increase in fabricated shipping containers and boxes.

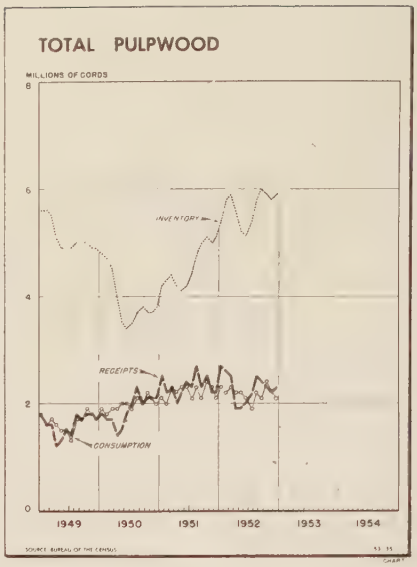
IMPORT TRADE

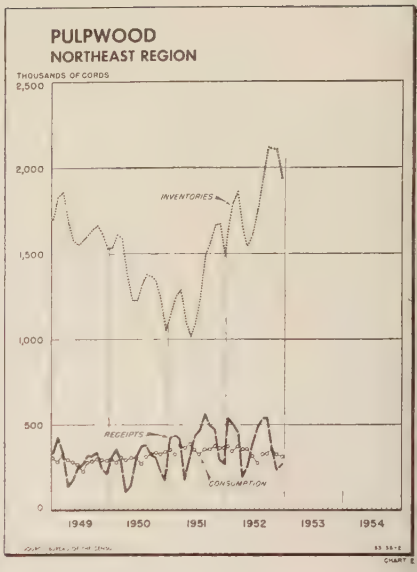
United States imports of pulpwood declined nearly 400,000 cords in 1952 below 1951. However, imports in 1952 were larger by a substantial margin than in either 1950 or 1949.

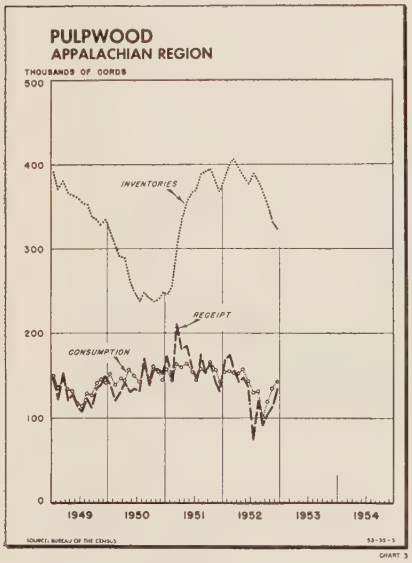
Wood pulp imports in 1952 declined below the previous two years.

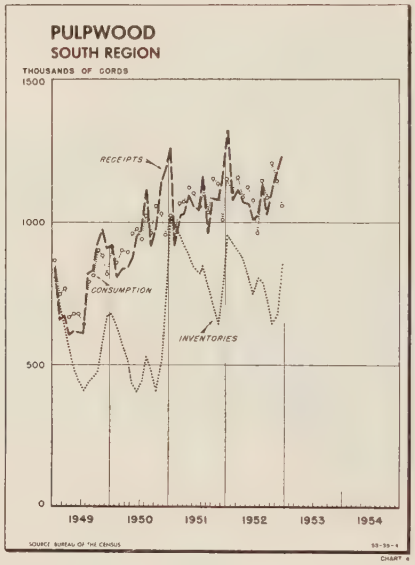
In the field of paper and paperboard imports, the only large item is newsprint which amounted to somewhat over 5,000,000 tons in 1952, a slight gain over 1951, but nevertheless the highest imports of newsprint paper on record.

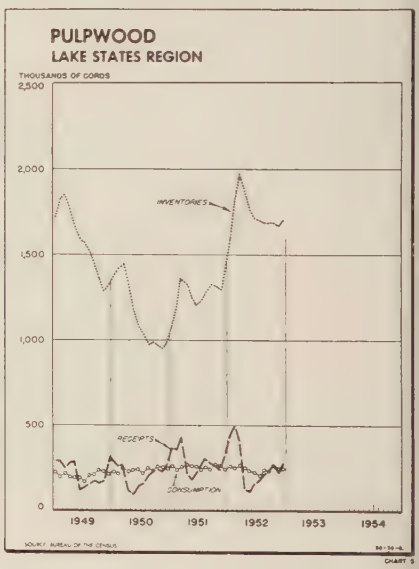
There was a noticeable decline in United States imports of paperboard in 1952. Imports of paper products at about 18,000 tons were up 4000 tons over the previous year. Increases in this field were scattered over a number of items.

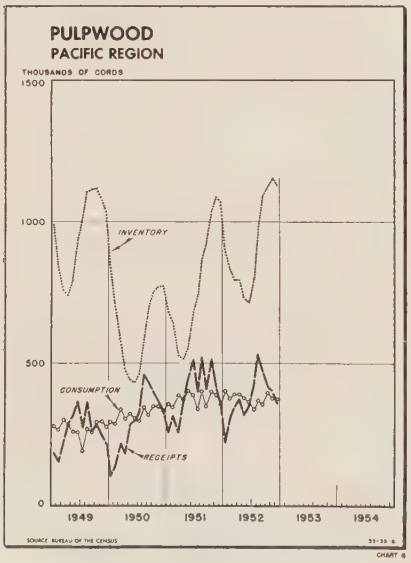


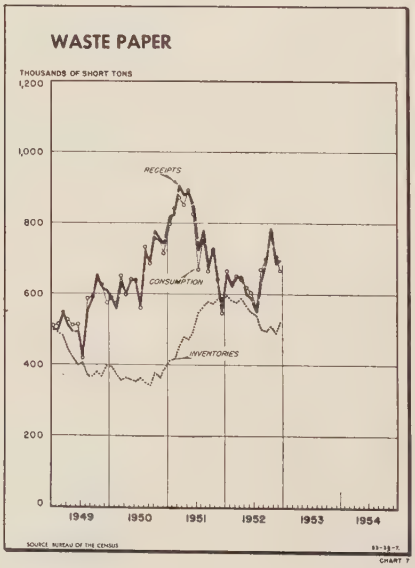


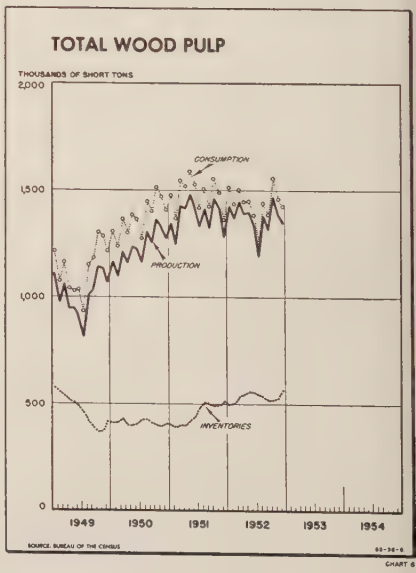












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DRY TENSILE AND MULLEN STRENGTH

RETENTION OF BEATER ADDITIVES

with RCI

BECKAMINE P-682-35

This urea-formaldehyde, cationic-type resin does more than give desired wet strength to your paper for toweling, bags, butcher and bread wraps, twisting tissues, boxboard liner, etc.

It also increases dry tensile and Mullen strength and helps the paper to retain such beater additives as clay, rosin size and starch.

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So strong is the water-resisting property of this Reichhold resin, you can dilute it infinitely with water with no precipitation. Apply it either at the beater or after the refining operation to bleached and unbleached kraft or sulfite, ground wood, rag or mixtures of these materials.

Get the full facts by writing for the booklet, "RCI Resins for the Processing of Paper."

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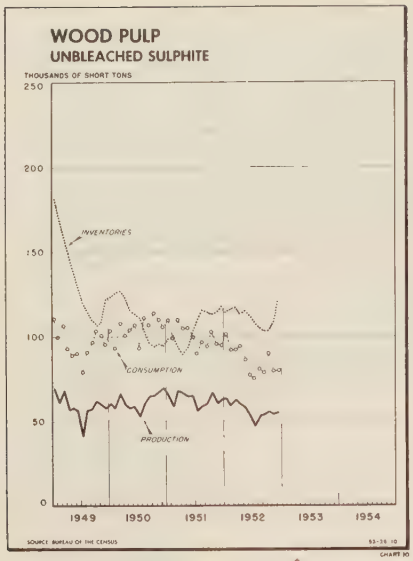
WOOD PULP
UNBLEACHED SULPHITE
THOUSANDS OF SHORT TONS
250
200
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INVENTORIES
CONSUMPTION
PRODUCTION
1949
1950
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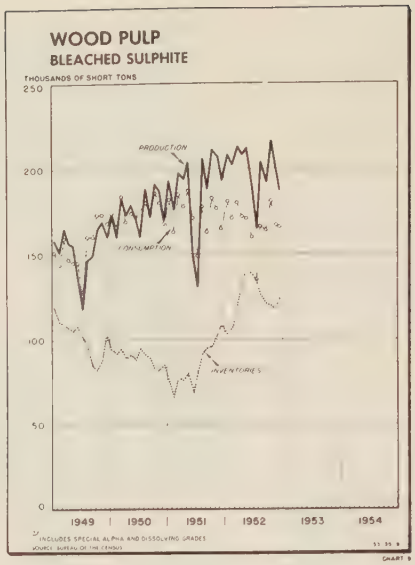
1954
SOURCE BUREAU OF THE CENSUS


WOOD PULP
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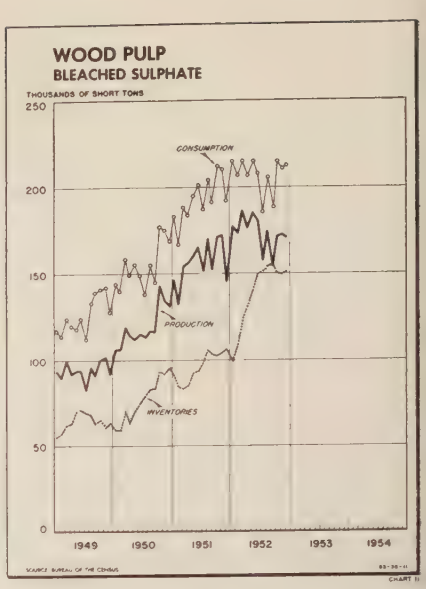
SOURCE BUREAU OF THE CENSUS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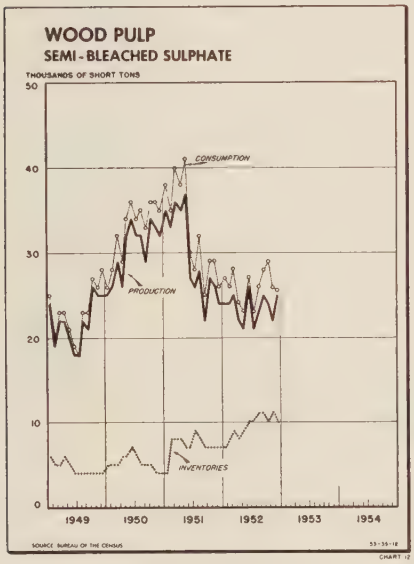
SOURCE BUREAU OF THE CENSUS


WOOD PULP
SEMI-BLEACHED SULPHATE
THOUSANDS OF SHORT TONS
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PRODUCTION
INVENTORIES
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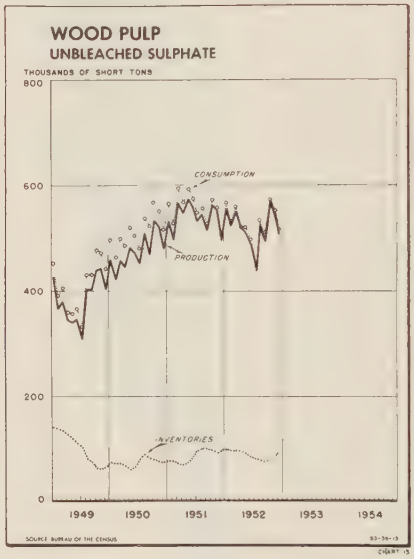
SOURCE BUREAU OF THE CENSUS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UNBLEACHED SULPHATE
THOUSANDS OF SHORT TONS
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PRODUCTION
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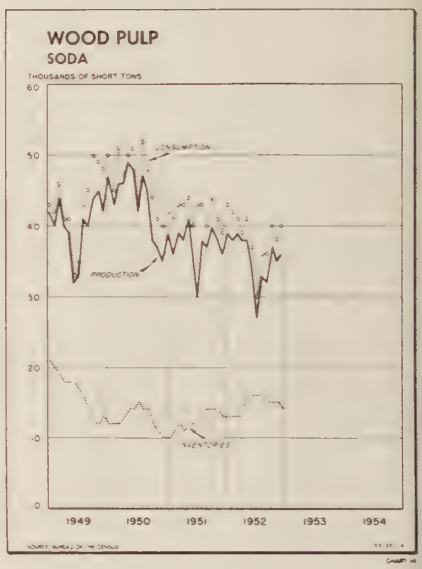
SOURCE BUREAU OF THE CENSUS


WOOD PULP
SODA
THOUSANDS OF SHORT TONS
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PRODUCTION
INVENTORIES
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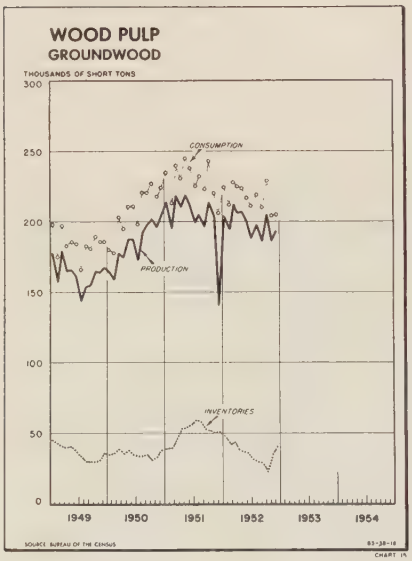
WOOD PULP
GROUNDWOOD
THOUSANDS OF SHORT TONS
300
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CONSUMPTION
PRODUCTION
INVENTORIES
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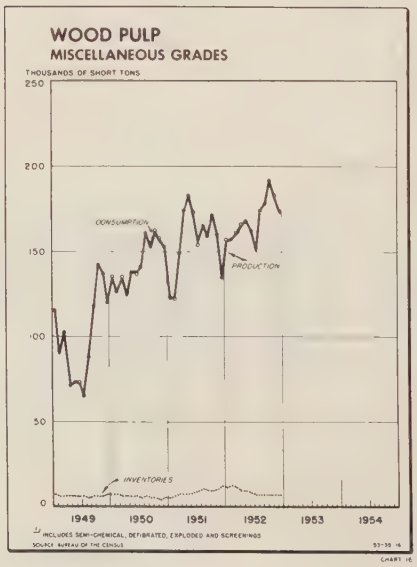
SOURCE BUREAU OF THE CENSUS


WOOD PULP
MISCELLANEOUS GRADES
THOUSANDS OF SHORT TONS
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CONSUMPTION
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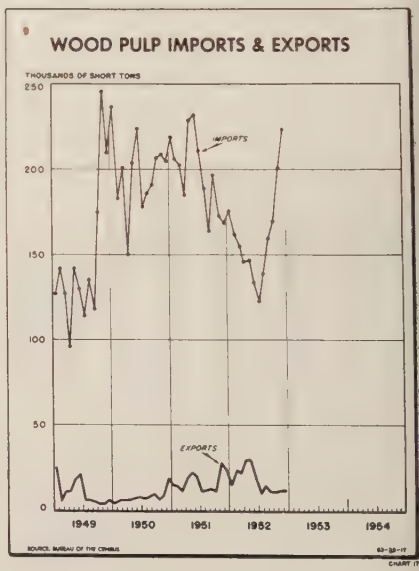
SOURCE BUREAU OF THE CENSUS


WOOD PULP IMPORTS & EXPORTS
THOUSANDS OF SHORT TONS
250
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150
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IMPORTS
EXPORTS
1949
1950
1951
1952
1953
1954
SOURCE BUREAU OF THE CENSUS

New mixing method delivers

Uniform 6% Stock

for faster processing, lower costs

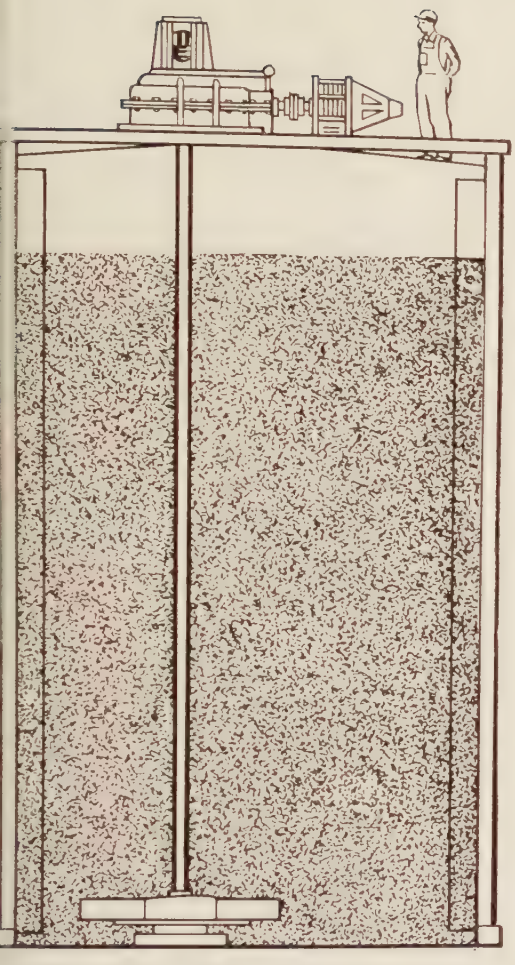
Here is a simple way to solve common problems of consistency, so often traceable to the stock chest.

Don't be satisfied with *half-mixed* stock. You can have fully uniform stock consistencies up to 6% from your stock chests —by using the LIGHTNIN mixing method shown here.

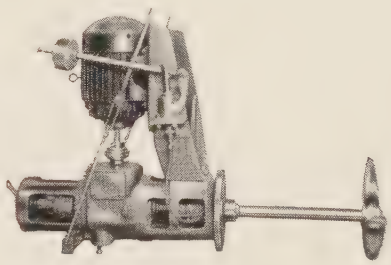
LIGHTNIN Mixers, properly installed, deliver the uniform high consistencies that your beaters and jordans are designed to handle best. LIGHTNINs enable you to predict—and control—stock consistency so accurately that stock dilution following the chest is practically unnecessary, and refining machines seldom, if ever, need to be reset.

And with uniform consistency stock coming through, the problem of diluting stock at the headbox is greatly simplified. Fewer safety measures are needed. You have much closer control over paper quality.

Plan now to investigate LIGHTNIN Mixers for your stock chests. For full information, write us today.



THIS KIND OF STOCK CHEST can deliver *fully uniform 6% stock* that processes faster and requires fewer control measures through the mill. Chest needs no baffles or midfeather; is simple to build and maintain. Mixing is done by a LIGHTNIN turbine-type mixer, carefully sized to mix the whole chest, or just the lower part of the chest, to *full uniformity*. These LIGHTNIN Mixers are supplied in sizes to 500 HP. They are factory assembled, fully guaranteed.



FOR RECTANGULAR CHESTS and smelt dissolving tanks. LIGHTNIN Side Entering Mixers are exceptionally easy to repack. Choice of stuffing boxes or mechanical seals. Sizes 1 to 25 HP.

FOR COATINGS, ADDITIVES and mixing chemicals. LIGHTNIN Portable Mixers clamp on any open tank or vessel. Thirty models to choose from. Sizes ⅛ to 3 HP.

Lightnin® Mixers

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This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints; complete description of LIGHTNIN Mixers.

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In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.

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- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-105 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

Please send me the catalogs checked at left.

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Title_____

Company_____

Address_____

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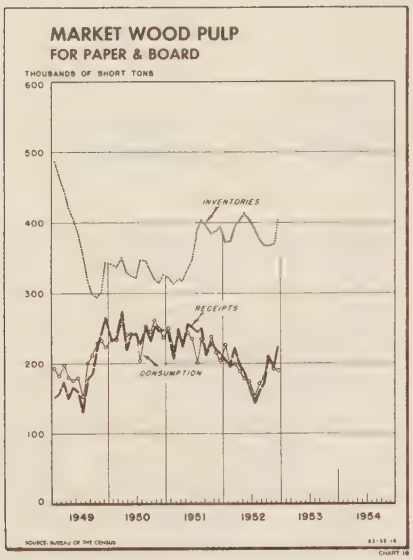
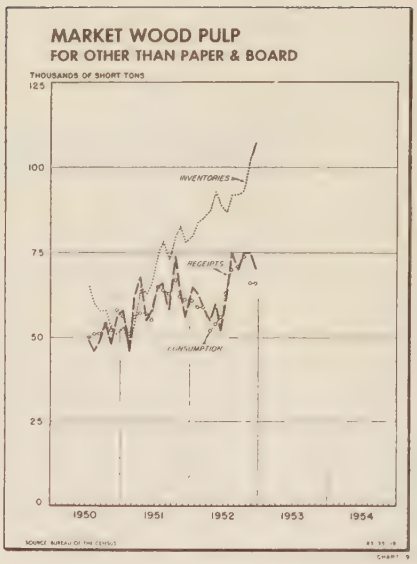
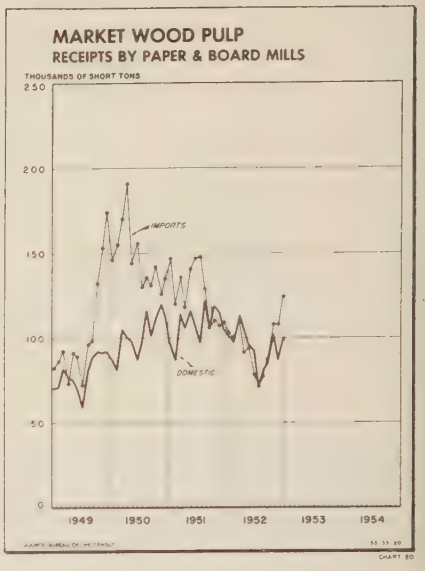
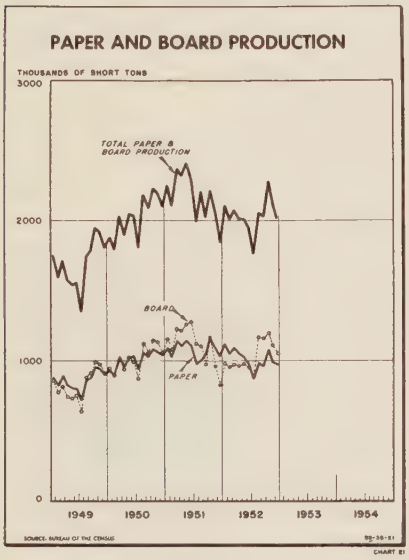
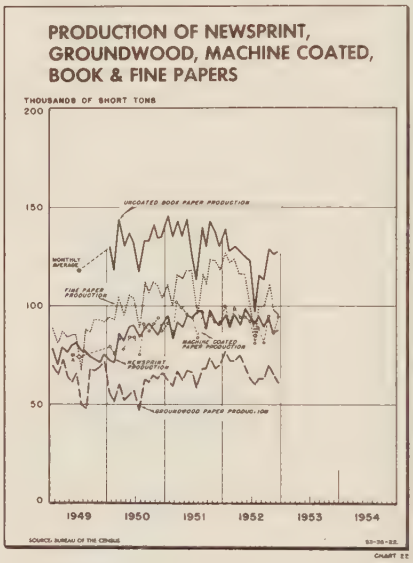

MARKET WOOD PULP
FOR PAPER & BOARD
THOUSANDS OF SHORT TONS
INVENTORIES
RECEIPTS
CONSUMPTION
SOURCE: BUREAU OF THE CENSUS

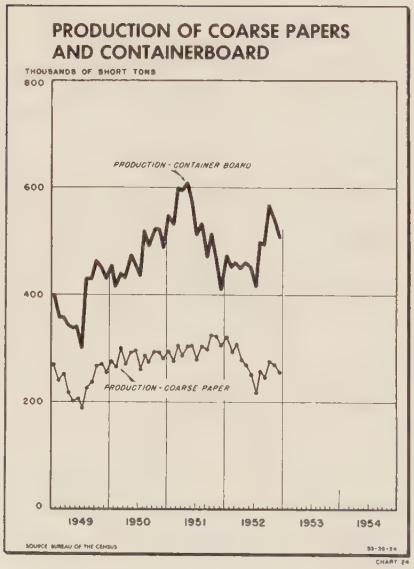

MARKET WOOD PULP
FOR OTHER THAN PAPER & BOARD
THOUSANDS OF SHORT TONS
INVENTORIES
RECEIPTS
CONSUMPTION
SOURCE: BUREAU OF THE CENSUS

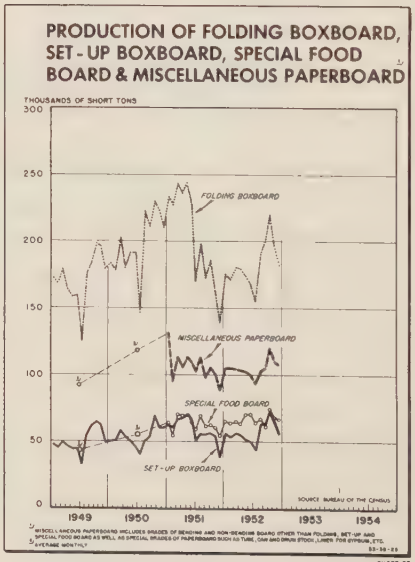

MARKET WOOD PULP
RECEIPTS BY PAPER & BOARD MILLS
THOUSANDS OF SHORT TONS
IMPORTS
DOMESTIC

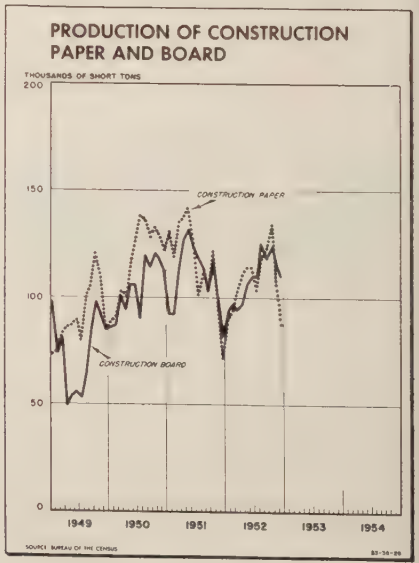

PAPER AND BOARD PRODUCTION
THOUSANDS OF SHORT TONS
TOTAL PAPER & BOARD PRODUCTION
BOARD
PAPER
SOURCE: BUREAU OF THE CENSUS


PRODUCTION OF NEWSPRINT, GROUNDWOOD, MACHINE COATED, BOOK & FINE PAPERS
THOUSANDS OF SHORT TONS
UNCOATED BOOK PAPER PRODUCTION
MONTHLY AVERAGE
FINE PAPER PRODUCTION
MACHINE COATED PAPER PRODUCTION
NEWSPRINT PRODUCTION
GROUNDWOOD PAPER PRODUC.-TION
SOURCE: BUREAU OF THE CENSUS

PRODUCTION OF SPECIAL INDUSTRIAL, SANITARY, TISSUE & ABSORBENT PAPERS
THOUSANDS OF SHORT TONS
SPECIAL INDUSTRIAL PAPER
ABSORBENT PAPER
SOURCE: BUREAU OF THE CENSUS

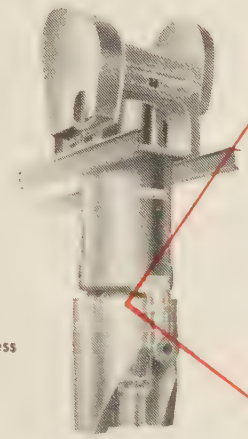

PRODUCTION OF COARSE PAPERS AND CONTAINERBOARD
THOUSANDS OF SHORT TONS
PRODUCTION - CONTAINER BOARD
PRODUCTION - COARSE PAPER
SOURCE BUREAU OF THE CENSUS


PRODUCTION OF FOLDING BOXBOARD, SET-UP BOXBOARD, SPECIAL FOOD BOARD & MISCELLANEOUS PAPERBOARD
THOUSANDS OF SHORT TONS
FOLDING BOXBOARD
MISCELLANEOUS PAPERBOARD
SPECIAL FOOD BOARD
SET-UP BOXBOARD
SOURCE BUREAU OF THE CENSUS

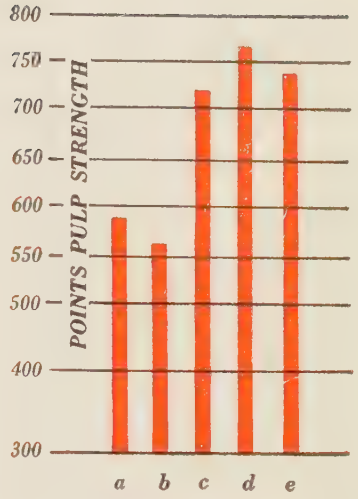

PRODUCTION OF CONSTRUCTION PAPER AND BOARD
THOUSANDS OF SHORT TONS
CONSTRUCTION PAPER
CONSTRUCTION BOARD
SOURCE: BUREAU OF THE CENSUS

What happens to SCREEN REJECTS in your mill ?

PULP CONTAINING 5% REFINED REJECTS SHOWS 7½% MORE STRENGTH THAN NORMAL HIGH YIELD KRAFT—WITH HIGH QUALITY APPEARANCE RETAINED



medium size
J-C Zenith Press



a. 100% rejects — one pass in high density refiner

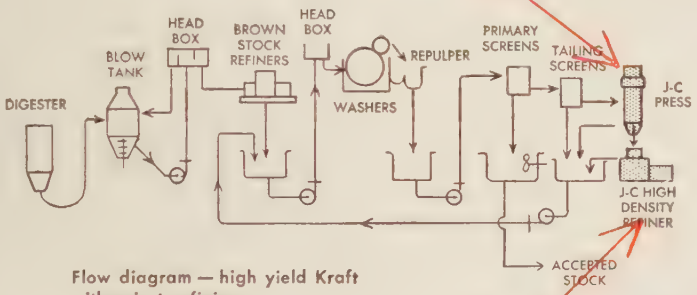
b. 100% rejects — two passes in high density refiner

c. Normal high yield Kraft pulp

d. 95% C & 5% A

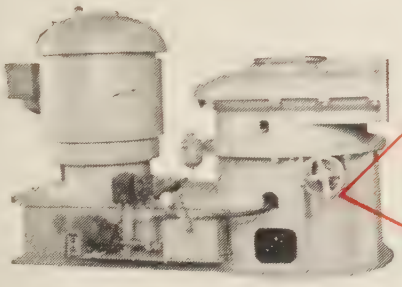
e. 95% C & 5% B

Points pulp strength = 2 × Mullen plus tear. (Note that pulp containing refined rejects is stronger than normal pulp and equal in appearance.)



Flow diagram — high yield Kraft with reject refining

RECENT TESTS PROVE A SUPERIOR PULP RESULTS FROM MIXING A PULP NOW LOST (REJECTS) WITH NORMAL HIGH YIELD KRAFT



J-C 015 Refiner

You can have similar savings with the simple installation of a J-C PULP PRESS and 015 HIGH DENSITY REFINER in your present system. Here's how the J-C system makes possible these remarkable savings . . .

After leaving the tailing screens the rejects are pressed to high consistency, processed in the specially designed 015 refiner and returned to the blow tank. A wide separation between the plates allows the 015 refiner to operate at high density with less power per ton of pulp. A striking feature of the 015-refiner is its inherent ability to produce long fibers, resulting in better tear.

THESE PLUS FEATURES OF THE J-C PRESS AND REFINER SYSTEM ADD UP TO EXTRA SAVINGS:

- By eliminating rejects, digester capacity is improved; cost of chemicals per ton is reduced.
- Reduces amount of dilution in black liquor.
- Output of mill is increased by amount of rejects (5%).

Our engineers and facilities are at your service. For information, write Dept.

J-C

JACKSON & CHURCH CO. SAGINAW, MICHIGAN

Work well done since eighty-one

Distribution of Paper and Board Production by Major Grade Groups by Type of Mill

WALLACE H. PEDERSON

An analysis of the production of the major grade groups of paper and board by types of mill, i.e, integrated, partially integrated, and mills nonintegrated with their pulp sources has not been made for ten years. The last study was made by the former War Production Board based upon data for the fourth quarter of 1943.

A current study of this nature is significant since it discloses the major importance of the numerous nonintegrated, as well as partially integrated mills, producing substantial percentages of a number of important grades of paper and paperboard. Many of the mills in these two groups are very small and oftentimes consist of only one or two older and narrower machines. They depend either entirely or partly upon purchased wood pulp, as well as wastepaper, rags, etc.

It is the importance of these smaller mills in the economy of the pulp, paper, and paperboard industry that brings forth the need for some form of wood pulp control during a period of emergency. For that matter, in time of pulp shortages, whether or not because of national defense requirements, the knowledge of the distribution of paper and board production should be of considerable help in recognizing these industry production problems and their many implications.

It should be kept in mind that production by nonintegrated mills does not necessarily mean that the furnish is all purchased wood pulp. Rather, many such mills utilize rags, wastepaper, or other fibrous materials such as straw, bagasse, sisal, etc., as an important part of their furnish.

Nonintegrated paper and board mills are considered as those having no control or affiliation with their source of supply for wood pulp, i.e, they purchase "market" pulp. Partially integrated mills are those who obtain some portion of their wood pulp from their own or affiliated sources and also purchase some "market" pulp. Integrated mills are those obtaining all of their wood pulp from their own or affiliated pulp mills.

Wallace H. Pederson, Chief, Program and Statistics, Pulp, Paper, and Paperboard, Forest Products Div., National Production Authority, U. S. Dept. of Commerce, Washington, D. C.

Oftentimes nonintegrated mills specialize in certain papers which are not suited to the facilities of larger "mass production" mills. These would include "specification" grades, custom-made-to-order in relatively small volume. Special "know-how" and techniques are frequently utilized by many of the smaller mills. The facilities and ability of the nonintegrated mills to make specialties requiring a constantly changing blend of raw materials would, on the other hand, present a headache to many of the large integrated mills.

Of the total of 18 major grade groups of paper and board, there are eight groups where 40% or more of national production is produced solely by the nonintegrated mills. On the other hand, the fully integrated mills account for at least 50% or more of the output of nine major grade groups.

The accompanying table shows the percentage distribution of 1951 paper and board production by major grade groups by type of mill.

Wholly integrated mills accounted for somewhat more than half; namely, 57%, of total paper and board production in 1951. Partially integrated mills produced 14% of the total and mills not having their own pulp sources, i.e., nonintegrated mills, produced 29% of total paper and board production.

Concerning paper grades only, integrated mills produced 62% of all grades of paper, partially integrated 22% and nonintegrated 16%. This distribution differs from the total paper and board because paper utilizes a larger proportion of wood pulp in its furnish while paperboard uses considerable amounts of wastepaper.

Newsprint production is virtually all an integrated operation. The 7% made by partially and nonintegrated mills is deinked newsprint and some standard newsprint produced by mills having some pulp facilities, probably groundwood pulp.

Groundwood papers, since their furnish is primarily groundwood pulp, are produced mainly by mills having their own pulp sources either in whole or in part. This accounts for only 6% being made by nonintegrated plants.

Eighty per cent of machine-coated paper production is produced by integrated mills as this item is one of the high-speed, mass-produced grades.

One half of the 1951 production of book paper was by integrated mills, one fourth by partially integrated, and one fourth by nonintegrated mills.

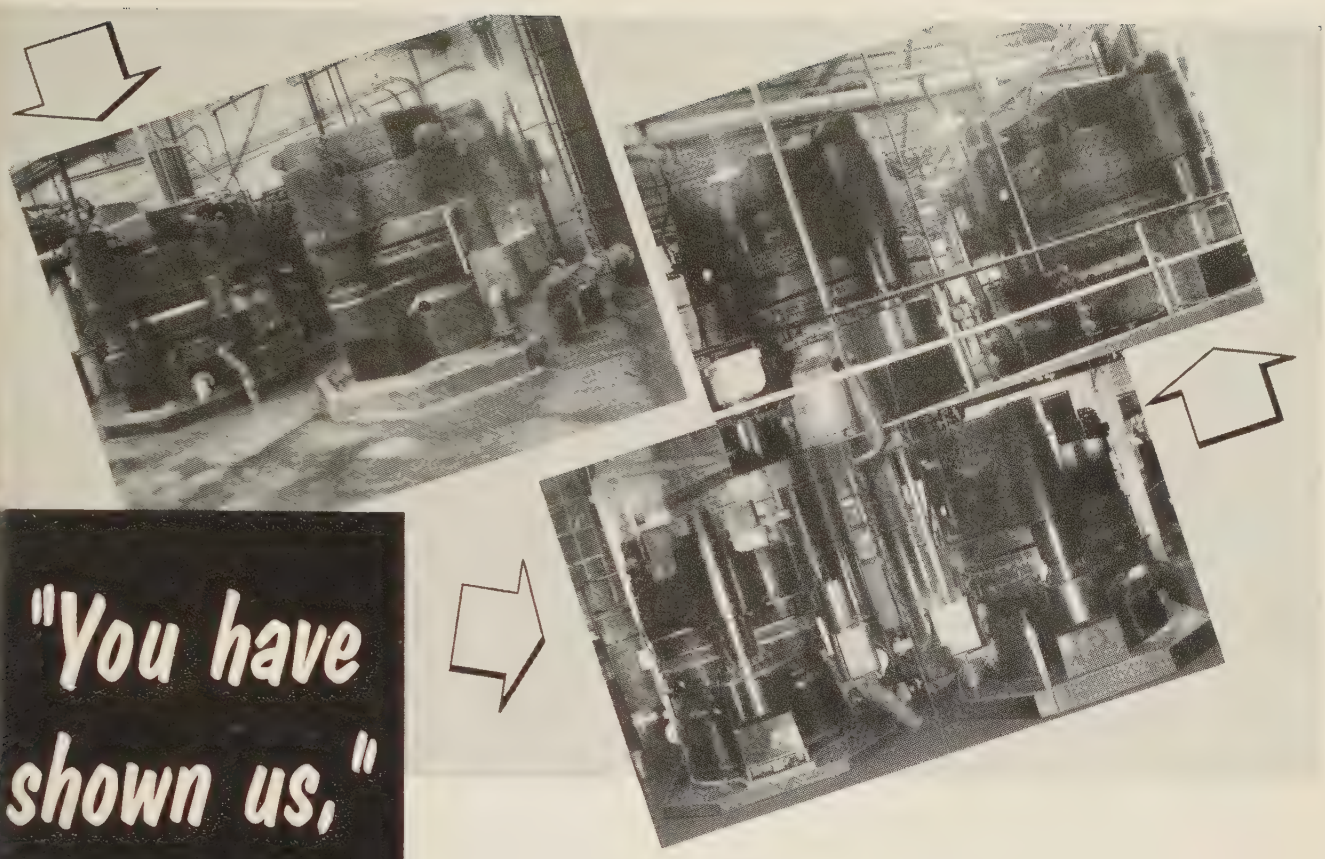
The distribution of fine paper production in 1951 was 37%

1951 Paper and Board Production by Major Grade Groups; Percentage Distribution by Type of Mill

Grade	Total all mills		Wholly integrated, %	Partially integrated, %	Non-integrated, %
	1000 short tons	%			
Total paper and board	26,048	110	57	14	29
Paper, total	11,624	100	62	22	16
Newsprint	1,108	100	93	7[a]	[b]
Groundwood	791	100	55	39	6
Machine coated	1,113	100	80	20[a]	[b]
Book	1,610	100	50	25	25
Fine	1,366	100	37	23	40
Coarse	3,627	100	75	14	11
Special industrial	408	100	67	14	19
Sanitary	1,244	100	29	48	23
Tissue	229	100	29	26	45
Absorbent	128	100	33	8	59
Paperboard, total	11,621	100	45	8	47
Container board	6,323	100	67	5	28
Bending board	3,272	100	22	12	66
Nonbending board	877	100	1	5	94
Special paperboard	1,064	100	16	14	70
Cardboard	85	100	13	29	58
Wet machine board	148	100	4	..	96
Construction paper and board	2,655	100	71	[c]	29[c]
Building paper	1,386	100	64	[c]	30[c]
Building board	1,269	100	78	[c]	21[c]

[a] Includes some production by nonintegrated mills. [b] Withheld to avoid disclosure of individual mill production. [c] Includes some production by partially integrated mills.

Source: Data compiled by Forest Products Div.—Pulp, Paper, and Paperboard, National Production Authority, from reports on Census Form M-14A and NPAF-21.



"You have shown us,"

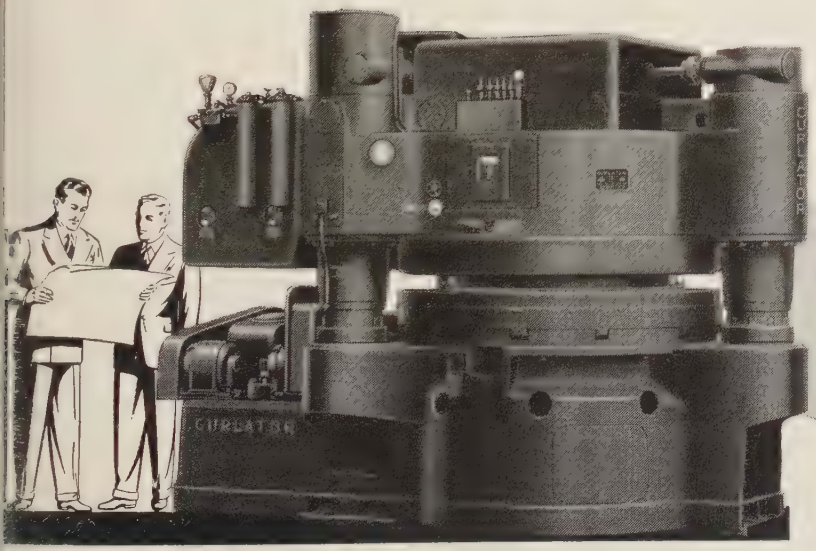
MILL MANAGEMENT SAID

Naturally, mill management men wanted proof that the Curlator would do the things we claim. They had to have proof—and rightly so—that Curlators

- would make substantial savings, up to 10% of their wood, as well as coal, sulphur and limestone . . .
- would upgrade No. 2 sulphite and fine screen rejects to No. 1 sulphite.
- would impart more desirable properties to their finished paper . . .
- would give continuous trouble-free operation . . .
- would pay for itself in a reasonable length of time.

Yes, mill management said, "You had to show us before we bought two, three or four Curlators." What happened? The first Curlators proved themselves so well that management in a number of mills, like the three pictured above, purchased additional machines to increase their curlated pulp tonnage.

Let us prove to you what Curlators can do for you . . . how the Curlator will pay for itself.



WRITE today for detailed information.

Canadian Representative—
Homad Services, Ltd., Montreal

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Corporation
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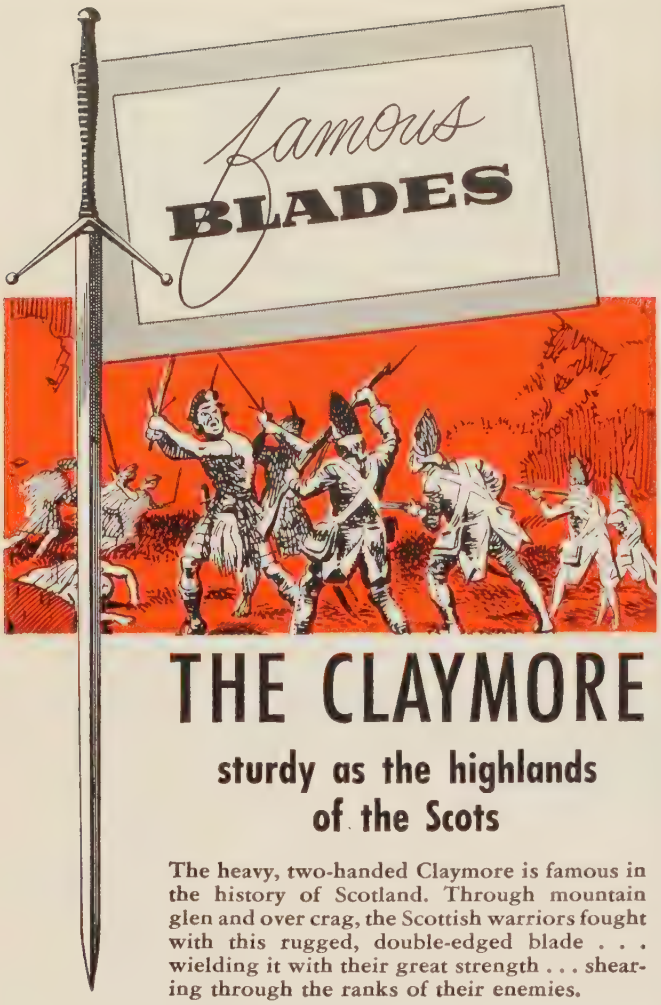
†T. M. Reg.—Curlator Corporation, Rochester, N. Y.

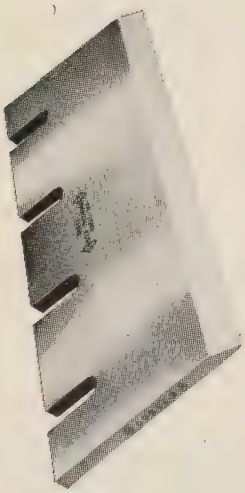


THE CLAYMORE

sturdy as the highlands of the Scots

The heavy, two-handed Claymore is famous in the history of Scotland. Through mountain glen and over crag, the Scottish warriors fought with this rugged, double-edged blade . . . wielding it with their great strength . . . shearing through the ranks of their enemies.

Heppenstall CHIPPER KNIVES



do a sturdy job in chipper lines

Exceptional service to the pulp and paper industry is a reputation earned by the rugged qualities of Heppenstall Chipper Knives. Results that are measured in terms of greater productivity and lower costs are:

- MORE HOURS BETWEEN GRINDS
- LESS SAWDUST WASTE
- LESS OVERSIZE CHIPS
- LOWER OVERALL BLADE COST

Make Heppenstall your standard specification for dependable Chipper Knife performance. Call your local Heppenstall representative.

Heppenstall

the most dependable name in chipper knives

PITTSBURGH 1, PENNSYLVANIA

Sales offices in principal cities

made by integrated mills, 23% by partially integrated, and 40% by nonintegrated mills. Considerable fine paper tonnage utilizes rags rather than wood pulp as the principal fibrous material and such producers usually also purchase their wood pulp requirements. Further, a number of fine paper grades are specialty items most economically produced in small mills without requiring investment for wood pulp facilities.

Seventy-five per cent of the coarse paper production in 1951 was produced by integrated mills. Grades such as kraft wrapping, bag paper, and shipping sack paper account for the major portion of the total and are made primarily by the large mass-production mills having their own sulphate pulp facilities. Included in the coarse paper group are also many specialty papers such as glassine and greaseproof often made by the nonintegrated mills who buy all or part of their pulp supplies through market sources. These specialty grades chiefly account for the 11% made by nonintegrated mills and also to some degree for the 14% made by partially integrated mills.

Special industrial papers consist of such items as file folder stock and tabulating card stock as well as many specialty grades. Sixty-seven per cent of this grade is made by integrated mills while the balance is made in partially integrated and nonintegrated mills.

Twenty-nine per cent of the 1951 sanitary paper production was produced by integrated mills, 48% by partially integrated mills, and the balance by nonintegrated. Chemical pulp, groundwood pulps, and wastepaper are used in producing these grades. The majority of grades using primarily all wood pulp are produced by mills obtaining all or part of their pulp from their own sources. There are many small nonintegrated mills producing sanitary papers who are able to purchase their pulp requirements and who also utilize wastepaper.

The tissue paper group comprises various grades made to a large degree by mills whose pulp requirements are such that they are able to purchase their pulp rather than have their own pulp facilities. This accounts for the fact that 45% of total tissue was produced by nonintegrated mills.

It is particularly noteworthy that 47% of the 1951 production of all grades of paperboard was produced by nonintegrated mills. However, this does not mean that those mills use and therefore purchase nothing but wood pulp for use in their manufacturing process. It is due, rather, to the fact that their principal raw material is wastepaper rather than wood pulp and consequently are nonintegrated as far as pulp is concerned. This is especially evident in bending or nonbending board, which are predominantly made of wastepaper.

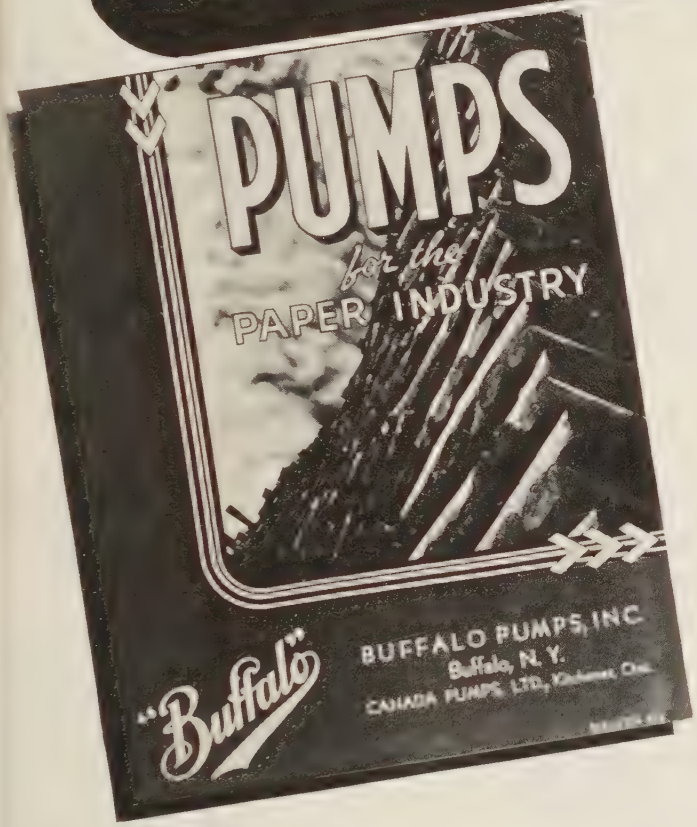
In container board, the major production was by integrated mills. The major tonnage of container board is liner board made from unbleached sulphate and is made to a large degree by integrated operations in the south. A further analysis of container board production might well reveal that the 28% made by nonintegrated mills is predominantly jute board.

Special paperboard grades and cardboard are made up of grades using wastepaper to a large degree and this accounts for the large percentage made by nonintegrated mills.

Wet machine board uses large amounts of fibrous materials other than wood pulp and consequently are produced by mills not needing their own pulp facilities.

Building paper and building board production in 1951 were made predominantly by mills having their own pulp mills. The grades of pulp utilized in producing these grades are special types such as defibrated or exploded, not available from market sources and consequently are produced and consumed in integrated operations. The balance of such production use other fibrous materials such as rags and wastepaper and therefore are not largely dependent on their own pulp sources to insure production.

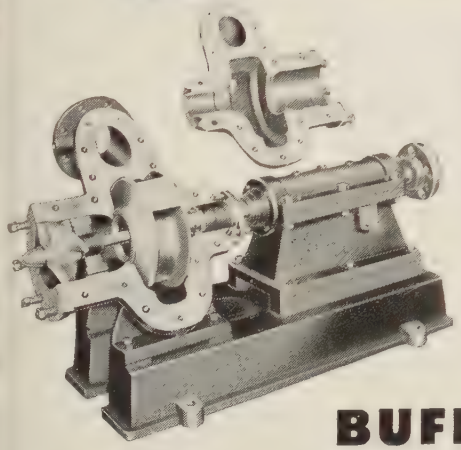
FACTS to help you PICK THE RIGHT STOCK PUMP!



WRITE TODAY

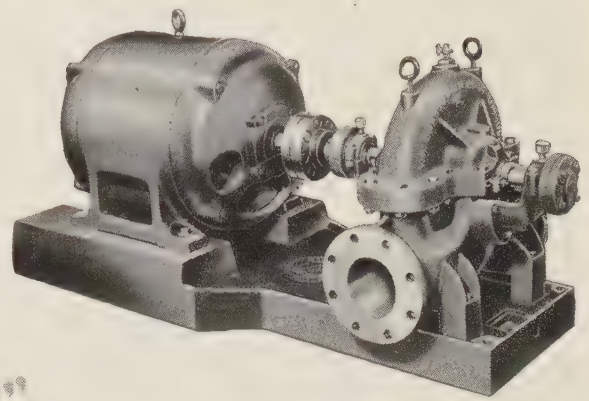
FOR THIS "BUFFALO" ENGINEERING BULLETIN 953

To get the pump that will be most satisfactory and economical over the years, these simple steps are necessary: (1) determine all hydraulic conditions, (2) look over a line of pumps that is complete enough to give you a model tailor-made for those conditions, and (3) pick a manufacturer whose pumps have been proved beyond a doubt over many years in paper and pulp mills all over the country. "Buffalo" Pumps give you this selection and assurance of performance. Developed by "Buffalo" engineers working closely with paper men, these pumps are built in the designs, sizes and trim for best performance on almost any liquid, any consistency or any head you may encounter. Bulletin 953 describes them all—why not write for your copy now?



Left, "Buffalo" Diagonally Split-Shell Pump with Non-clogging Impeller, for handling high-consistency stock. Upper half of casing is removed.

Right, "Buffalo" Type SL Double Suction Pump for handling white water.



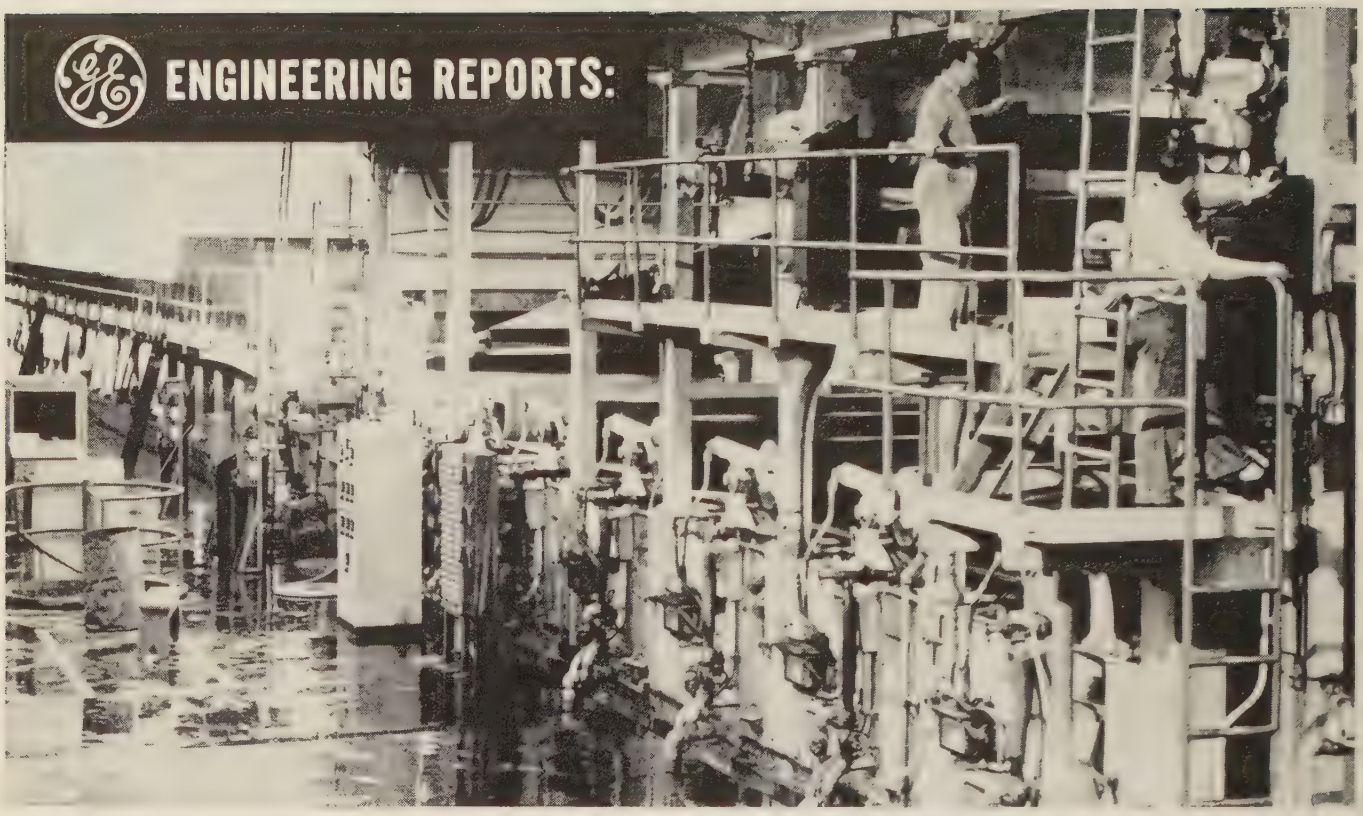
"Buffalo" BUFFALO PUMPS, INC.

528 BROADWAY BUFFALO, N. Y.

Subsidiary of Buffalo Forge Company

Canada Pumps, Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

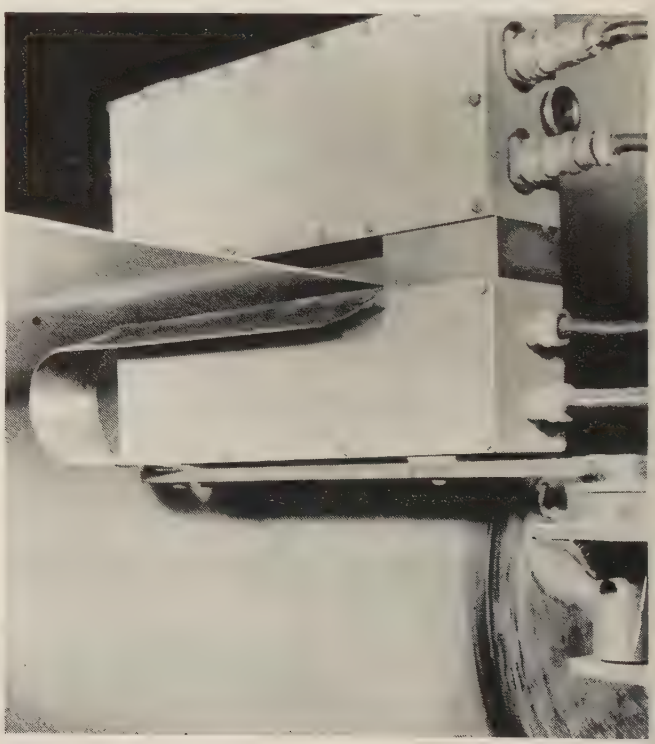


OPERATION—fast, convenient. At Fibreboard, G-E sectional drives keep machines at maximum production—maintain draws accurately, respond to adjustment quickly.

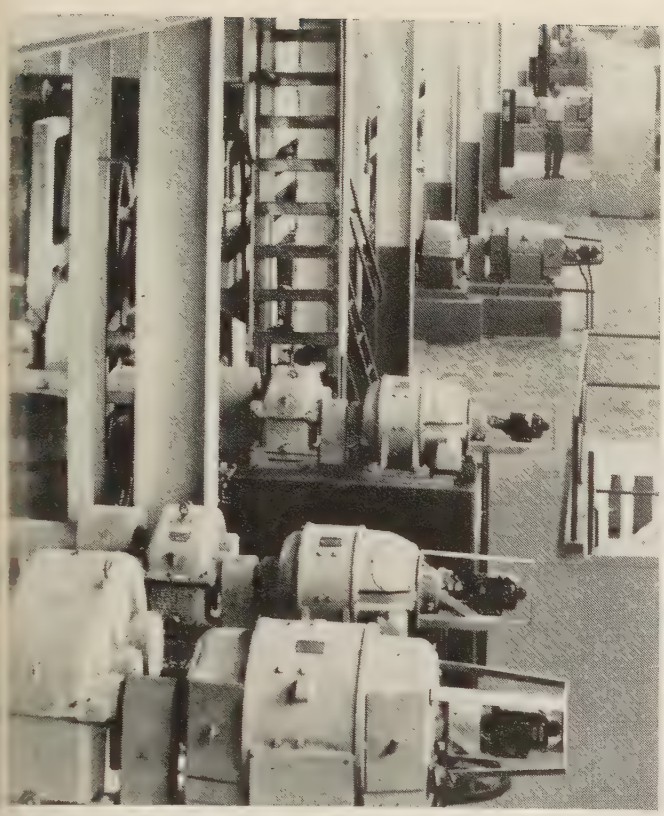
MAINTENANCE—machine outages reduced. For co-ordinated maintenance, sections can be operated independently or together. Components are reliable, need only routine attention.

Drive flexibility at Fibreboard helps

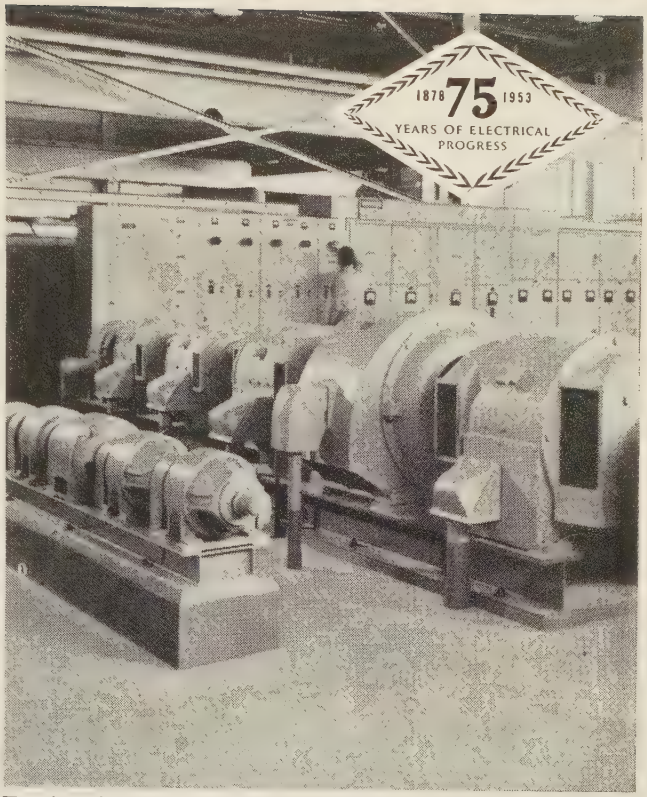
ADAPTABILITY—meets changing operating techniques. A G-E paper tensiometer like this was readily installed to control paper tension automatically at Fibreboard.



Another new production equipment at Fibreboard is the General Electric beta-ray gage, above. It measures paper basis weight continuously without touching the sheet.



INSTALLATION—costs less, takes less space. G-E sectional drives make back side of machines more accessible—provide for more efficient machine operation and maintenance.



Further, because the motor-generator sets and compact G-E control (above) are located away from the machines, valuable production-area floor space is saved.

keep output and quality high

Low installed costs, high production continuity, increased paper-machine adaptability provided by two G-E multiple-generator sectional drives

Fibreboard Products Inc. produces board in their mill at Antioch, Cal., on a cylinder machine and a Fourdrinier machine, both equipped with General Electric multiple-generator sectional drives.

Here is what Fibreboard says:

1. Installation was less expensive. Compact G-E drives went into place easily, quickly—made back sides of machines more accessible. To save floor space, motor-generator sets and control were located away from machines. Result: lower installed costs.

2. Operation is convenient, precise. Precise draw and quick slack take-up control mean quick, accurate machine adjustment. Fast, regenerative braking and reversing, and smooth, fast starts reduce lost time due to grade changes, breaks, etc. Section ammeters give visual check for many paper-making variables. Result: increased high-quality production.

3. Machine downtime for maintenance is reduced. Routine maintenance for felt and wire changes is speeded—any section can be operated independently. Preventive maintenance techniques are used during routine shutdowns, since section ammeters often indicate mechanical difficulties before they arise. Result: greater production continuity.

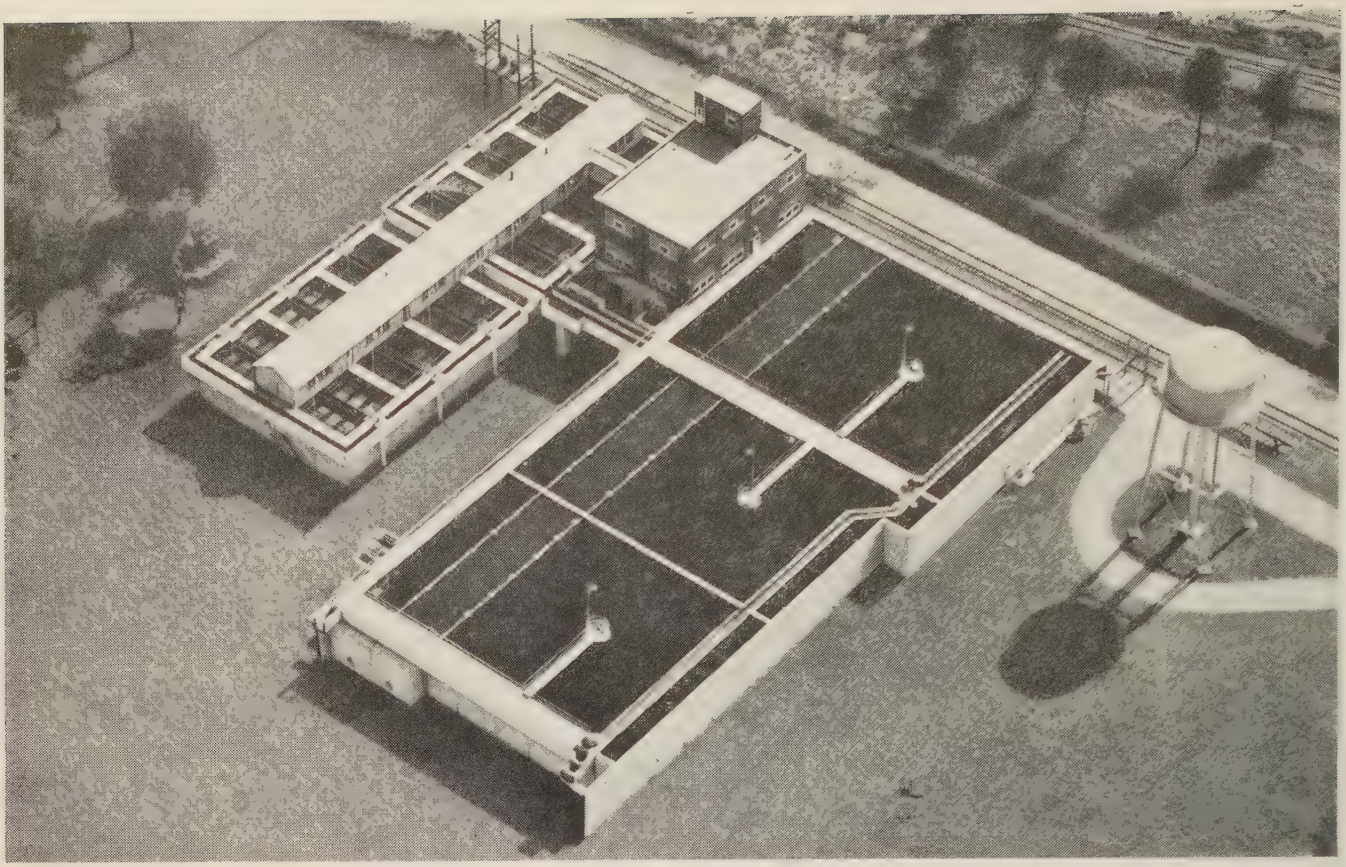
4. Drives keep pace with growth. Because of the inherent adaptability of G-E drives, future machine changes or re-arrangement can be made at minimum investment. New production equipments like the tensiometer and draw indicator can be readily applied. Result: flexibility to meet changing markets.

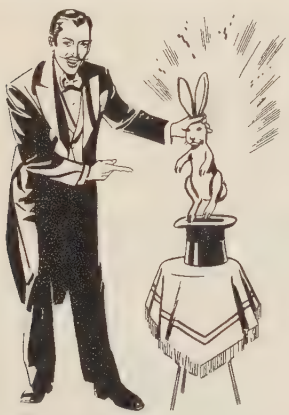
Contact your G-E sales engineer at the nearest G-E Apparatus Sales Office for more data on getting the same improved performance from your paper machines. General Electric Company, Schenectady 5, N. Y.

655-13

Engineered Electrical Systems for Paper Mills

GENERAL ELECTRIC





There's No "Magic Formula"

Every water treatment problem is different

No two water treatment problems are exactly alike. To get the best — and most economical — answer to your specific problem requires careful analysis of raw water composition, rate of flow and the results you require.

There *is* no magic formula . . . no single equipment unit that will give ideal results under all conditions. That's why it will pay you to check both conventional and high-rate units on every water treatment problem.

For a brief picture of the complete Dorr equipment line ask for Bulletin #9141. The Dorr Company, Stamford, Conn.

Repeat order in 1950 "proves out" a "conventional" installation made in 1948.

Quick facts about the Dorrco installation at the Hollingsworth & Whitney Co., Chickasaw Mills, Mobile, Alabama

1948 . . . First order installed with a design capacity of 10 MGD.
- 2 Dorrco Flash Mixers
- 1 Dorrco Flocculator
- 1 Dorrco Squarex Clarifier, 85′ square

Operating Results . . .
- Raw water: Color — 65-70 ppm
- Raw water: Turbidity — 3.5-3.9 ppm
- Finished water: Color — 3 ppm
- (Dosage in ppm: Alum 20, Soda Ash 15, Chlorine 3 to 5)

1950 . . . Second order installed with design capacity of 16 MGD. (Total design capacity: 26 MGD)
- 1 Dorrco Flash Mixer
- 2 Dorrco Flocculators
- 2 Dorrco Squarex Clarifiers, 75′ square

Flocculator and Squarex are trademarks of THE DORR COMPANY—Reg. U. S. Pat. Off.

Every day, nearly 8 billion gallons of water are treated by DORR equipment.

Better tools TODAY to meet tomorrow's demand

DORRCO

DORR

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SOLAR COLORS

for tinting white paper

brightness outstanding for brilliance

fastness superior fastness to light

dispersion quick, uniform distribution of dye throughout the stock furnish

non-caking resistant to dampness and high humidity

process stability normal fluctuations of temperature, acidity, alkalinity or machine speed do not affect uniformity of shade

versatility Solar Blues and Solar Violet used alone, in conjunction with one another, or shaded with Solar Pink or Solar Green, produce a full range of eye appealing whites

deliveries stocks carried in warehouses strategically located throughout the country insure prompt deliveries

GENERAL DYESTUFF CORPORATION

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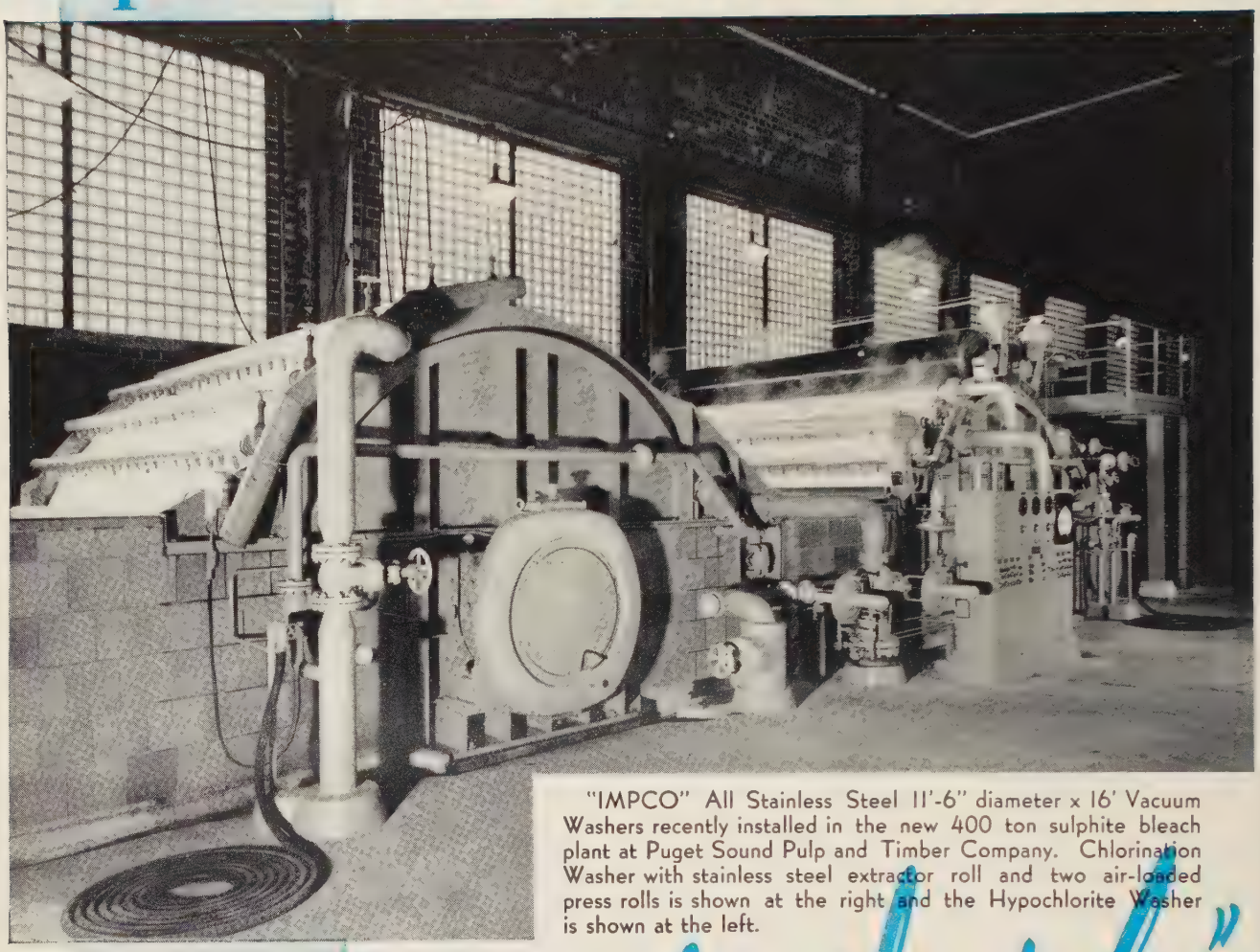
Impco Bleach Plant Washers



"IMPCO" All Stainless Steel 11'-6" diameter x 16' Vacuum Washers recently installed in the new 400 ton sulphite bleach plant at Puget Sound Pulp and Timber Company. Chlorination Washer with stainless steel extractor roll and two air-loaded press rolls is shown at the right and the Hypochlorite Washer is shown at the left.

"tailored-for-the-job"

Stepping up the production of bleached pulp to keep pace with increasing demands is a big problem today. To do this - and yet maintain uniform high quality is another.

In both instances, these are problems which need individual solutions. To solve them, equipment designed for your own particular plant is needed.

That is why "IMPCO" "tailored-for-the-job" design can be the answer for you.

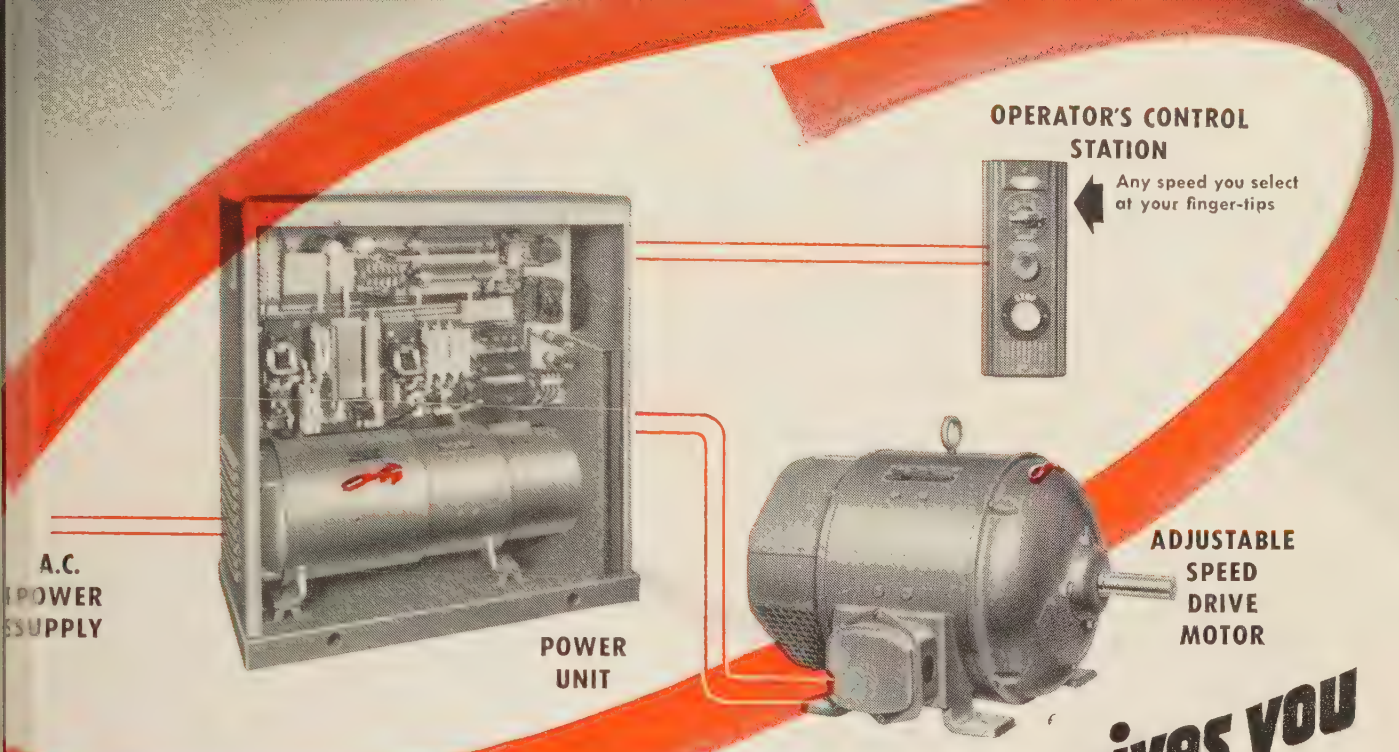
Every "IMPCO" Bleach Plant Washer is correctly engineered to fit your needs, to give you the necessary flexibility in tonnage and above all, quality production.

If you are planning a new bleach plant or an increase in production in your existing plant, "IMPCO" offers you a complete line of equipment for any type of system, including chlorine dioxide.

With an experienced "IMPCO" representative working step-by-step with your engineers, you can be sure of the answer that is best for you.

IMPROVED MACHINERY INC.

Nashua, New Hampshire



uis Allis SELECT-A-SPEDE Drive gives you

PRECISION SPEED CONTROL FROM YOUR A.C. LINES

real answer to many of your operating and production lems is right here — with the Louis Allis-Select-A-e Drive, featuring the new Magnetic Amplifier Con- This drive provides unusual flexibility and positive rol — flexibility and control you never thought pos- from an A.C. line. You get increased production from machines, fewer operating headaches, with the exact l you need for your job — when you want it, where want it.

k these Select-A-Spede features:

for practically every need — units up to 150 horsepower.

e free operation — as a result of advanced design and the use lustrial duty components.

ss speed range — from 1/8 base speed or less to greater than speed. Special designs permit speed ranges to five times base speed where required. A wide variety of optional features are available, too: inching, jogging, sequence control, reversing, dynamic braking, and multi-motor ranges.

Superior speed regulation — even at low threading speeds — better than required on most machines. Use of the magnetic amplifier and a special anti-hunt circuit maintains speed constant regardless of load.

Complete protection — against overload and runaway.

Clean, filtered air — supplied under pressure to power unit. Keeps dust and dirt out — reduces maintenance.

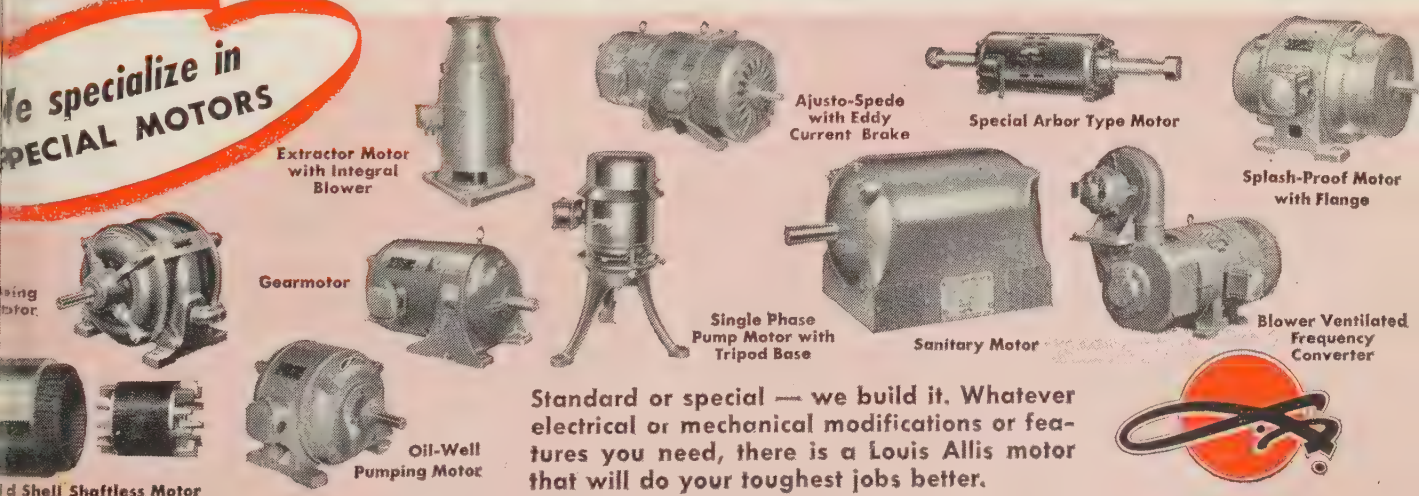
There are probably many operations in your own plant right now where a Select-A-Spede can save you time and trouble — boost production and efficiency.

Look into this drive's many unusual, practical features. Write today for further information about the money-saving advantages of the Louis Allis Select-A-Spede or contact the district office nearest you.

A-101

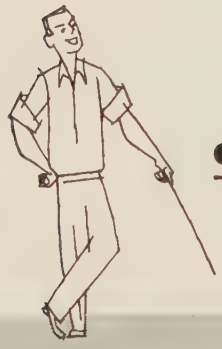
THE LOUIS ALLIS CO., Milwaukee 7, Wisconsin

e specialize in PECIAL MOTORS



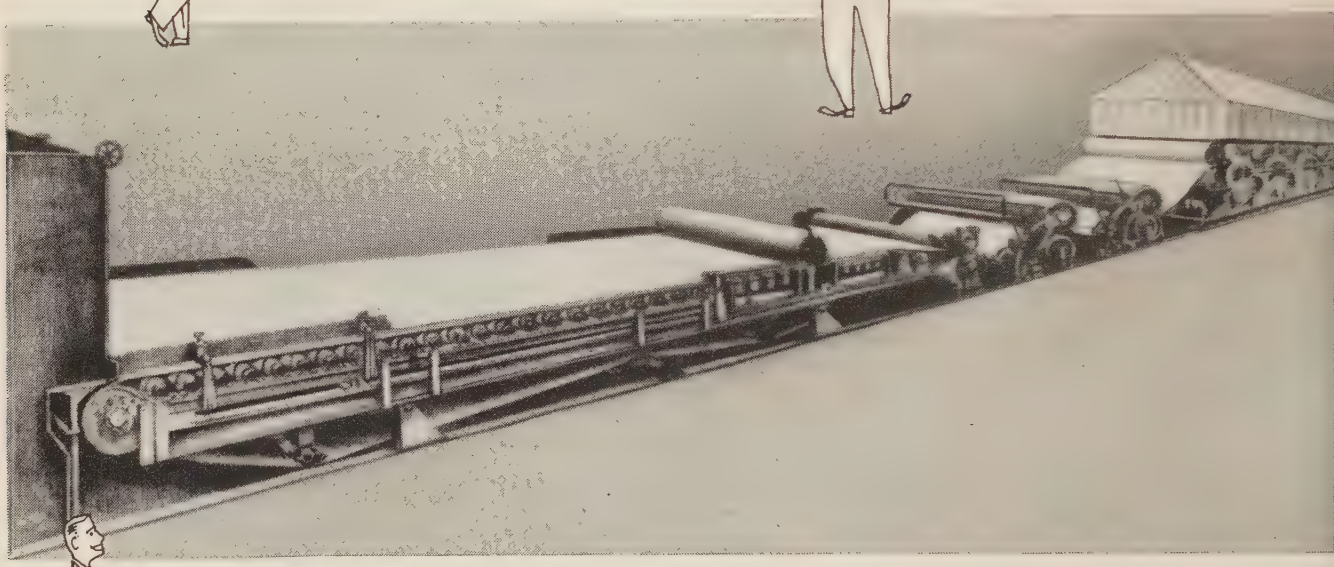
Standard or special — we build it. Whatever electrical or mechanical modifications or features you need, there is a Louis Allis motor that will do your toughest jobs better.

How controls pitch trouble... at lowest cost



coats
pitch particles
destroys stickiness

keeps
machines cleaner
longer



THE most foolproof method of correcting pitch trouble is to use Celite*. Simply introduce small quantities of Celite into the system where pitch particles are still small. The porous, absorbent Celite forms a coating over the pitch particles, destroying their stickiness. They then pass through the machine and become an integral part of the sheet. Thus your production stays up, down time for cleaning the machines is reduced.

Celite also adds many desirable qualities to your finished sheet. This light, porous filler gives higher brightness and opacity . . . improved ink receptivity and absorption . . . surface smoothness . . . control of gloss. In fact, you can "build in" to your sheet almost any combination of these qualities by using the right grades and quantities of Celite.

A Celite field engineer will gladly show you how Celite can help you produce better paper at lower cost. For his services, simply write Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CELITE PRODUCTS**

FOR THE PAPER INDUSTRY

for DEXTRINS that are right on the target

. . . Call a National technical service man.

White Dextrins
Yellow Dextrins
British Gums
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Specially Converted Dextrins

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When You Want Service...

Call SOLVAY FIRST

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for these Paper-Making Chemicals

Only Solvay offers you a specialized paper makers' Technical Service—a staff of highly skilled experts who are specialists in the paper field. These technicians are always at your service, ready to help with your problems.

And for prompt delivery service, Solvay has three centrally-located manufacturing plants... thirteen convenient branch sales offices... and a nation-wide chain of warehouses and stock points situated right in paper-making areas.

So when it's service you want, call *Solvay first* for these paper-making chemicals.

Soda Ash

Caustic Soda

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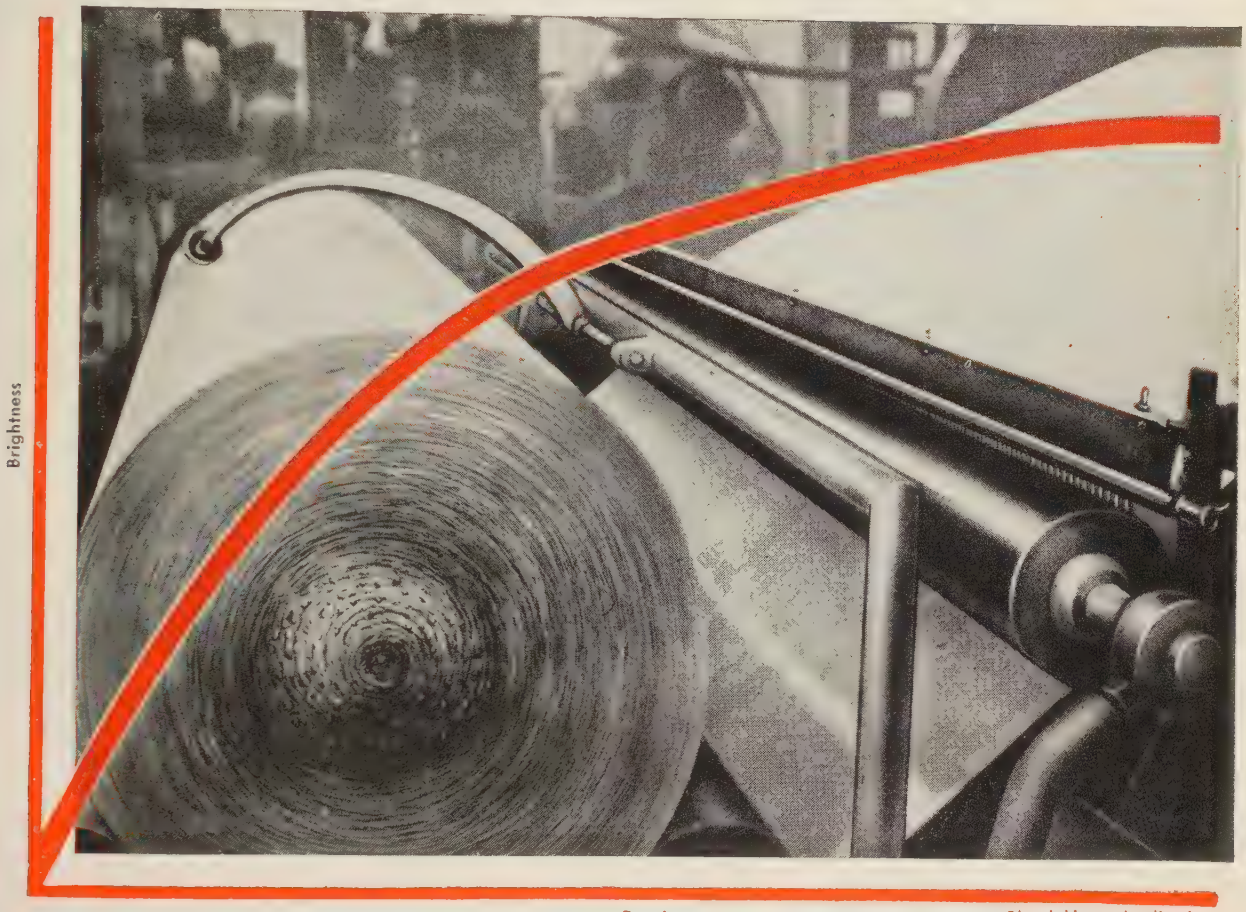
HOLLINGSWORTH & WHITNEY, Mobile, Alabama pla

High Density Bleaching of Chemical and Mechanical Pulps with Hydrogen Peroxide

BECCO
HYDROGEN PEROXIDE AND OTHER PEROXYGEN CHEMICALS



Bleach Liquor Application on the Kamyr machine

Chemical and mechanical pulp webs and cut chemical pulp sheets can now be bleached at much higher chemical concentrations and at higher chemical efficiency than heretofore. Color stability for reasonable periods of time is excellent.

The new Becco high-density method is suitable for use on any self-sustaining web-producing machine or cut sheets can be bleached by the mill previous to use. Equipment requires a minimum of valuable mill space.

Methods and equipment for semi-automatic or fully automatic high-density pulp sheet bleaching are in an advanced stage.

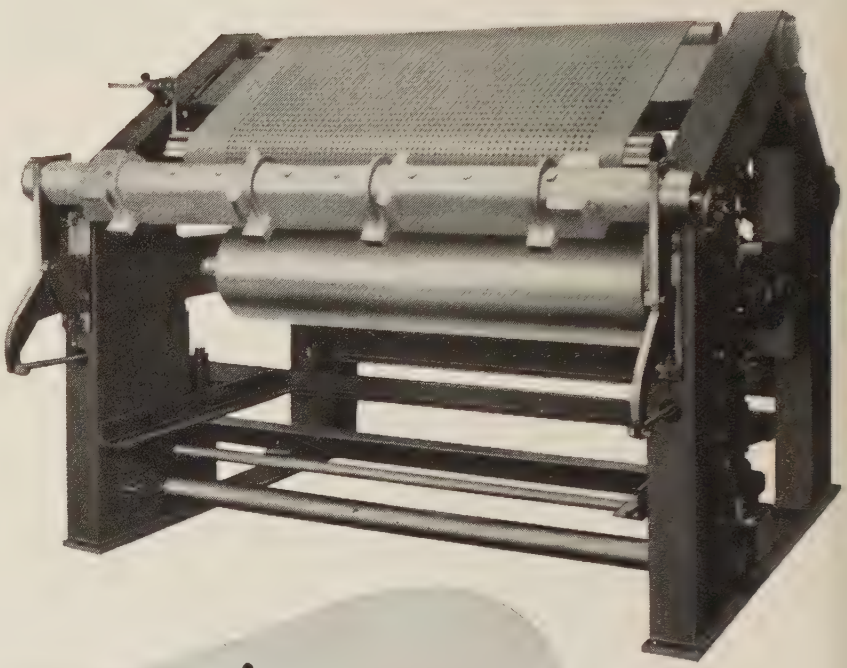
For full information write Becco or talk with any Becco representative.

Buffalo Electro-Chemical Company, Inc.

DIVISION OF FOOD MACHINERY AND CHEMICAL CORPORATION

Sales Agent: BECCO SALES CORPORATION, Station B, Buffalo 7, N. Y. • Buffalo • Boston • Charlotte • Chicago • New York • Philadelphia • Vancouver, Wash

Egan



air coater

Featuring new advanced design,
the Air Coater coats one side of a web with the
coating metered by a "knife" of high velocity
air. Ideal for photographic, book, label, litho
and adhesive coatings; and sensitized emulsions.

Send for pamphlets on coating, treating and laminating

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Bound Brook, New Jersey

Designers and builders of: Treaters, Gummers, Laminators, Crepers, Air Dryers, Waxers, Coaters, Festooners, Saturators, Printers, Embossers, Winders and Special Machinery for Paper Converting.

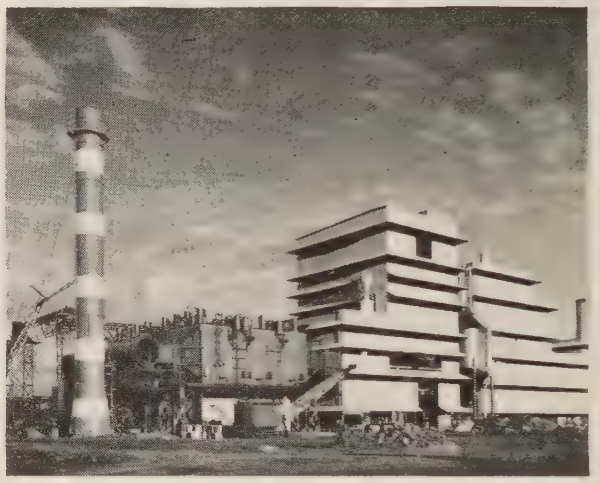
Cable Address: "EGANCO"—BOUNDBROOK, N. J.

NEW ENGLAND—one in a series of scenes where Appleton Wires serve the paper industry.

PRACTICALLY everywhere you find a paper mill, you will find Appleton Wires. Though you ordinarily think of New England as the birthplace of new world traditions, rugged coastlines and industries of the sea—such as lobstering—it also has 277 paper mills, most of which know that *Appleton Wires are Good Wires!*

APPLETON WIRE WORKS, INC., APPLETON, WISCONSIN

New St. Regis Mill at Jacksonville . . .



. . . all steam by C-E

Located on a two hundred acre site on the outskirts of Jacksonville, Florida, this new kraft pulp, paper and board mill represents an important step in the long-range expansion program of the St. Regis Paper Company. Outstanding in many respects, this mill contains nearly a million dollars worth of equipment installed specifically to eliminate or materially reduce the problems of waste disposal.

All steam generating equipment for this new mill was supplied by Combustion Engineering. It comprises: (1) a Chemical Recovery Unit designed to burn 900,000 pounds of black liquor dry solids per 24 hours; (2) a Power Boiler (VU-50 type) to burn oil or natural gas and designed to supply 160,000 lb of steam per hr; (3) a Bark Burning Boiler equipped with high set spreader distributors and continuous discharge grate to produce 135,000 lb of steam per hr. All the steam generating equipment is designed to operate at 625 psi and 750 F.

The choice of C-E equipment for this outstanding new mill is well justified, we believe, by the consistently fine performance record of similar C-E units in major pulp and paper mills throughout the country.

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

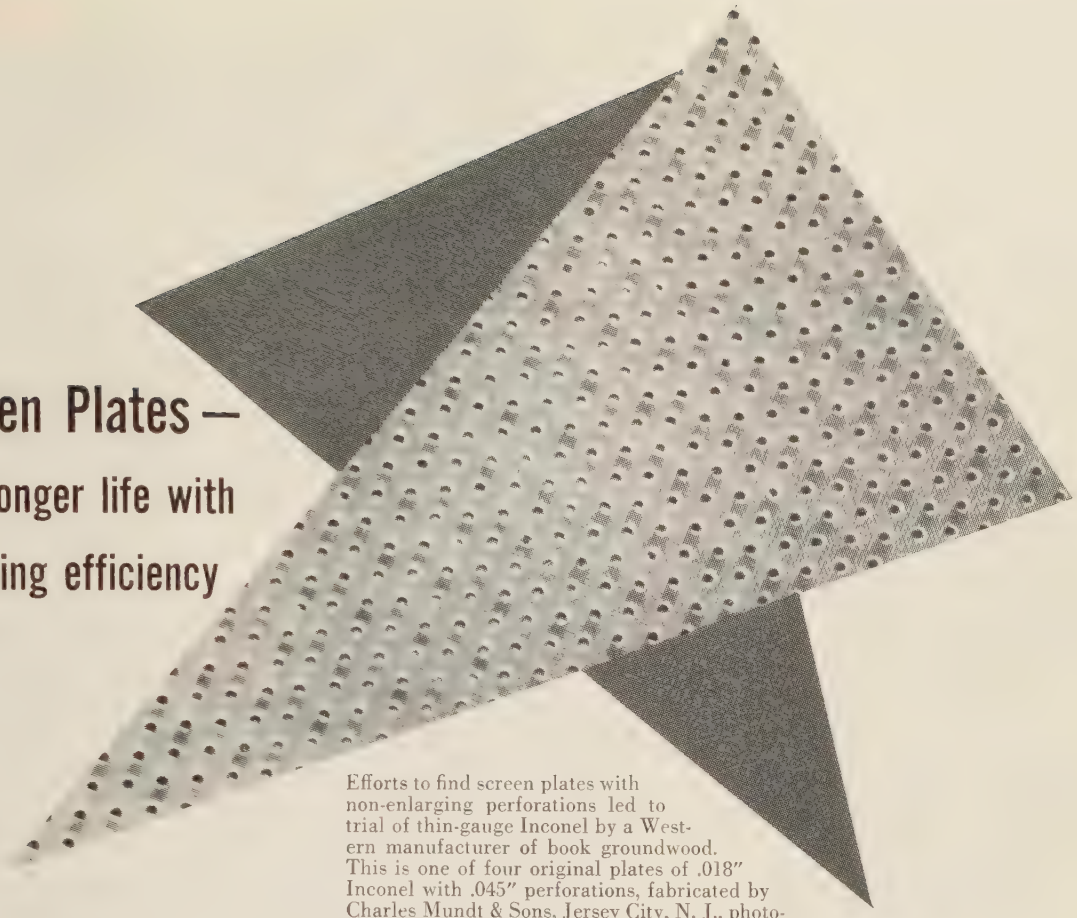
B-657

PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT, AND PRESSURE VESSELS

nconel Screen Plates—

6½ times longer life with

uniform screening efficiency



Efforts to find screen plates with non-enlarging perforations led to trial of thin-gauge Inconel by a Western manufacturer of book groundwood. This is one of four original plates of .018" Inconel with .045" perforations, fabricated by Charles Mundt & Sons, Jersey City, N. J., photographed after more than three years of use.

Before they could produce high grade book groundwood from Western softwoods, Crown Zellerbach Corp., W. Linn, Oregon, had to solve several problems. Short screen plate life was one of them.

Screen plates were corroding beyond use in less than 5 months. Screening efficiency was dropping throughout the service life, as corrosion enlarged screen perforations.

Even heavy 17-gauge plates didn't do the job. Of course, they minimized breakage and slowed down the rate at which the holes enlarged — but not enough. As a result, volume and consistency of stock varied — and stock quality with it.

In looking for plates whose perforations *wouldn't* enlarge — whose screening efficiency would stay high and constant — the mill installed a trial set of four Inconel® plates in October, 1949. They were light (only .018") — so light, that you could curl a corner around your finger. But with solid backing at the frame ribs, these Inconel plates turned in an amazing performance.

On the strength of it, the mill later installed 36 more Inconel plates, bringing the total to 40. Of 14 that eventually failed, none gave less than 16 months of continuous service—and nine were on the job 25 months or more. Two of the original trial set lasted more than 36 months! What's more, the mill reports the Inconel plates still in use gave "an average of 26 months of service as compared with 3 to 5 months" for previous plates. They have found "no . . . measurable enlargement of the perforations even after 36 months of continuous use."

They estimate that they'd have replaced 300 of the old-style plates since 1949 — if they hadn't changed to Inconel. As it is, they've replaced only 14 — a clear saving of 286 plates. And they've improved the quality of their book groundwood in the bargain.

Next time you need screening equipment, think what Inconel can mean... in improved product quality, lower operating and maintenance costs, lighter weight construction, or longer service life.

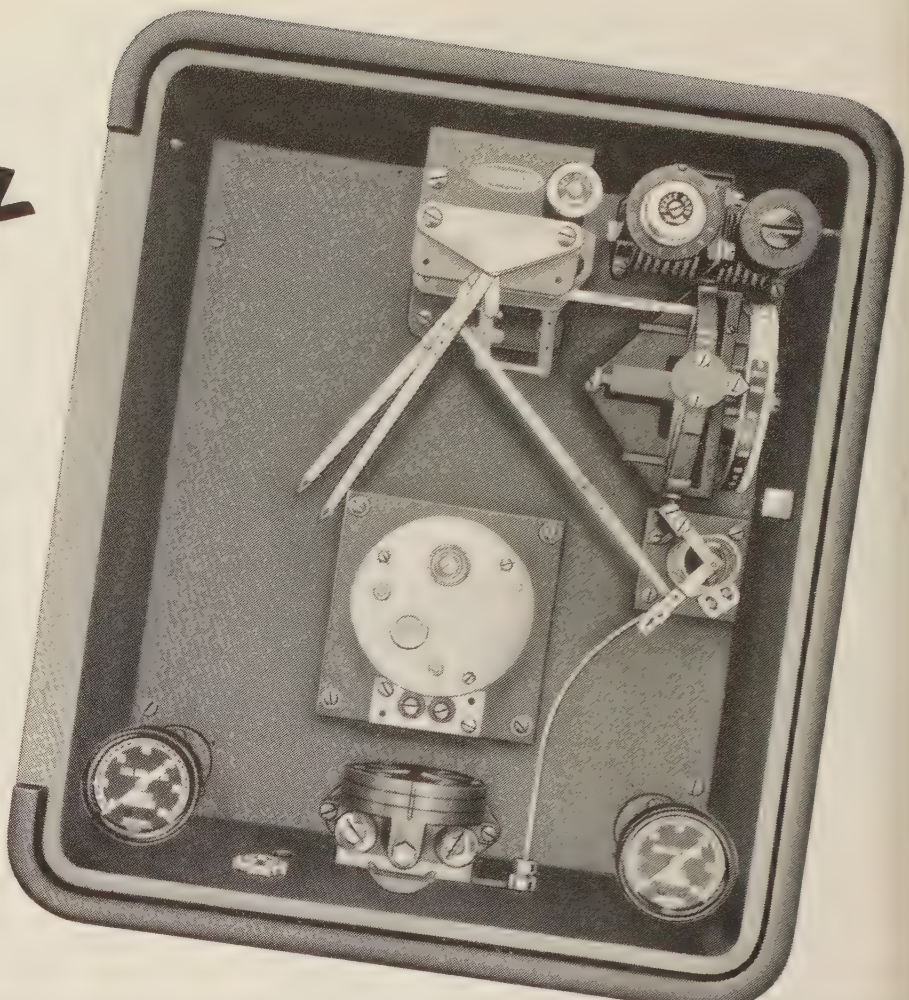
It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY®
NIMONICS® • NICKEL • LOW CARBON NICKEL • DURANICKEL®

INCO TRADE MARK

See it Work in your plant



Masoneilan 60000 Series Controller

Ask a Mason-Neilan engineer to bring a demonstrator model into your own office or plant — and see the difference. Note these outstanding qualities . . .

GIMBAL UNIT

See how *ONE CONTROL MECHANISM* gives you *FOUR COMBINATIONS* of primary and feedback motion to obtain Direct or Reverse Proportional (includes On-Off), or Differential Gap control.

SIMPLE ADJUSTMENT

Make only ONE SETTING — without removing chart — to select type of control, direction of action, and percent proportional band or differential-gap. See how easy to adjust, test and service, too, because all unit assemblies are directly accessible, easily detached, interchanged. Note how all air passages are manifolded.

STUBBORNLY DEPENDABLE

Accurate, stable performance, plus unequaled simplicity, versatility and reliability make the Masoneilan 60000 Series Pneumatic Controller the *Instrument Man's Instrument* for pressure, temperature, liquid level or flow control.

(Call in a Mason-Neilan engineer at your earliest opportunity)

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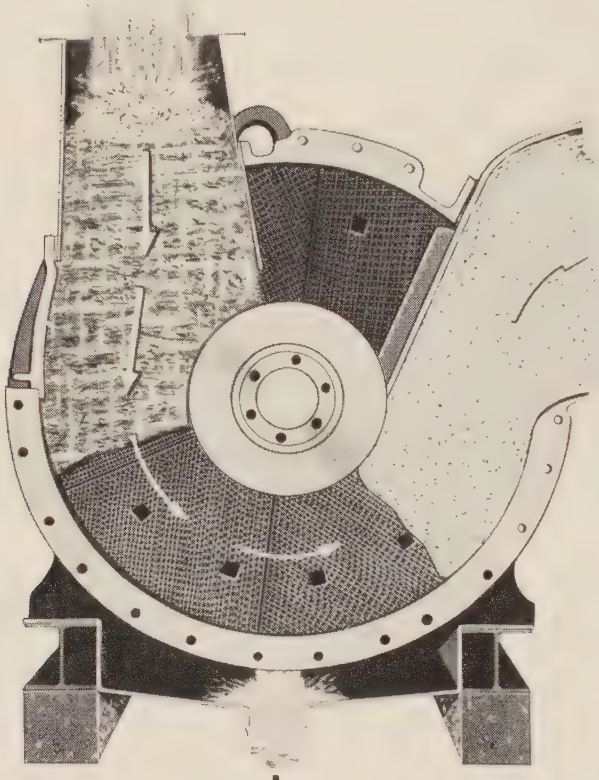
HIGH DENSITY at LOW COST

with the DAVENPORT CONTINUOUS PRESS

Low Density Stock
From Thickener or Filter
8%-12% Consistency

Intake



High Density Discharge
To High Density Storage
Consistency up to 35%-40%

Back to Pulper or Beater

Stock enters the press through the top opening of the intake hopper, and flows between two large revolving discs, the faces of which come progressively closer together as they approach the discharge point.

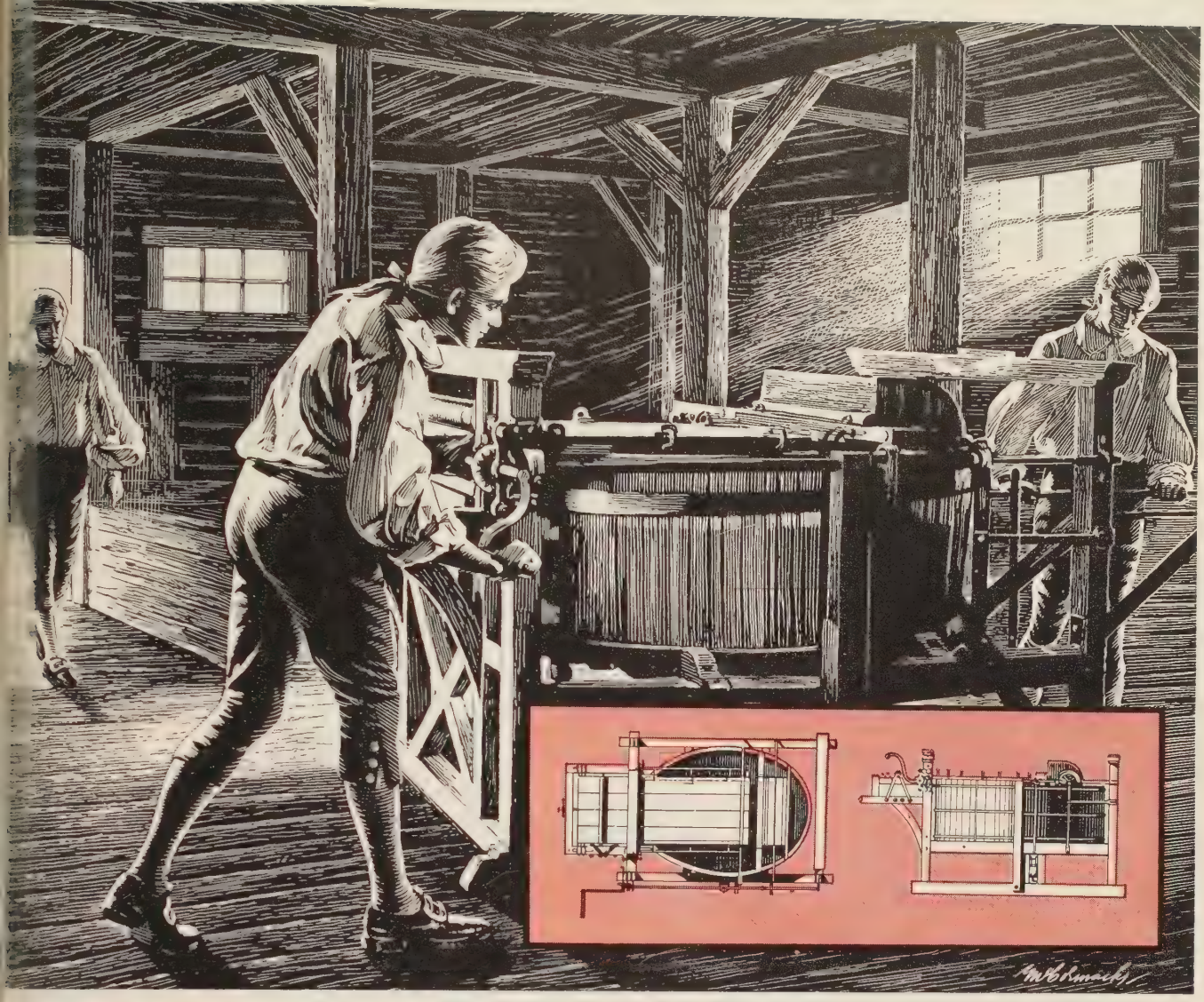
The pressure exerted expels the water which passes through the perforated screens and leaves the press at the bottom and goes back to the pulping process. The fibers act as a filtering medium, aiding the screen plates in preventing an excess of pulp from passing off with the liquid. The resulting high density stock is discharged into the outlet by means of a discharge bar.

Davenport Continuous Presses are built for heavy duty service. All parts in contact with the material are corrosion resistant. The design is simple, with few wearing parts. As a result, maintenance costs are extremely low. Power costs are also low.

Presses are made in 3 capacities to handle from 15 to 75 tons B.D. every 24 hours. They are manufactured by Davenport Machine & Foundry Company and sold to Pulp and Paper manufacturers exclusively by American Defibrator, Inc. For further information, ask for Bulletin.

AMERICAN DEFIBRATOR, INC.

CHRYSLER BUILDING
NEW YORK 17, N. Y.



Papermaking Went Into High Gear With This Machine in 1798...

An important event in the history of papermaking was Nicholas-Louis Robert's invention of the paper machine over a century and a half ago. No longer would the slow methods of forming paper by hand limit size and quantity of paper sheets. Robert's machine formed paper of continuous length upon an endless woven-wire cloth which retained the matted fibers. Today more complex machines, operating on the same principle, produce a tremendous volume of paper. Helping maintain its quality are high-grade raw materials produced by A. E. Staley Manufacturing Company, supplier to leading mills for more than 30 years. Discover the many advantages Staley can offer *you*. See your supplier or write for details today.

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Staley's

Quality Staley® Products for Papermakers

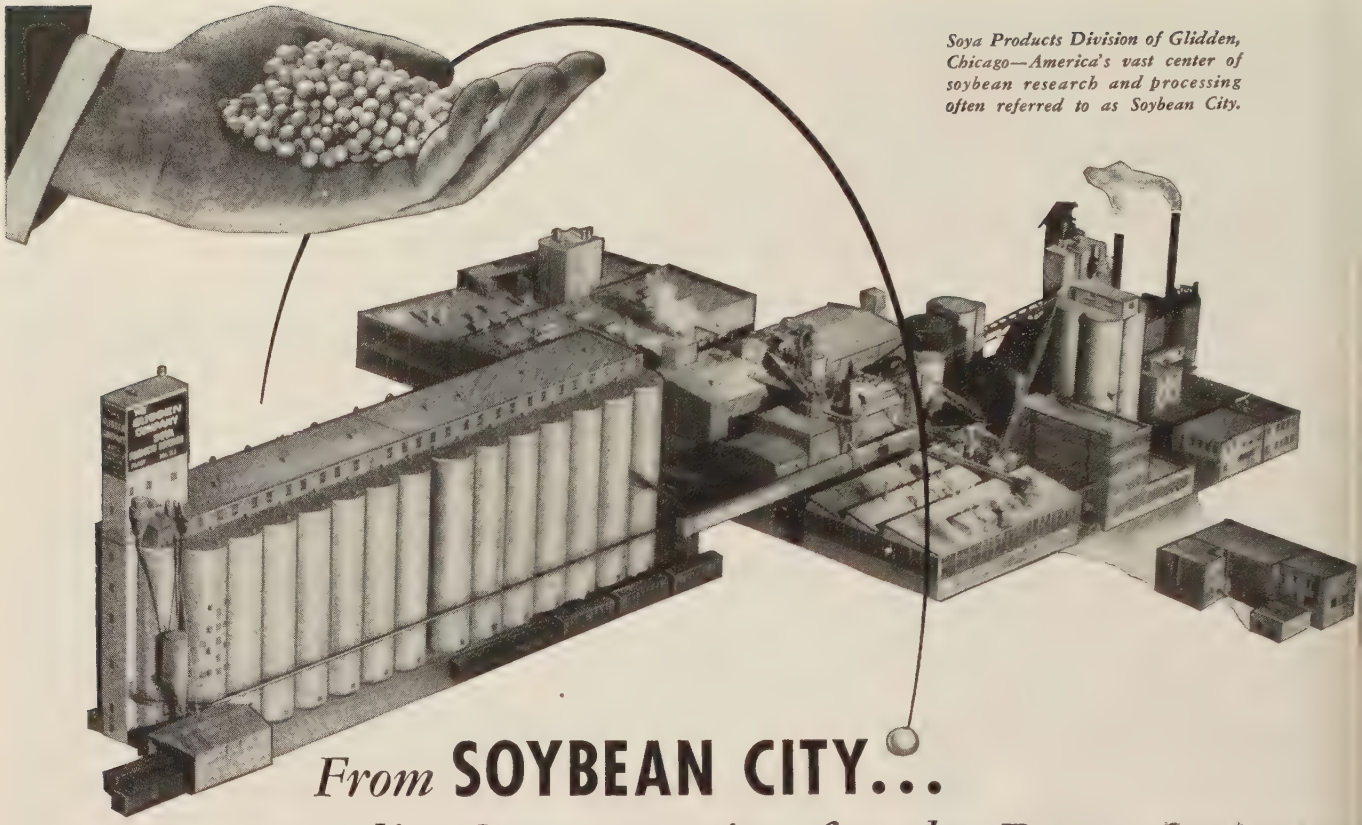
Staley Sizing Starches
A full range of starches and dextrins for beater, surface and calender sizing.

Staley Corrugating and Laminating Adhesives
Corrugating starches, special laminating and bag adhesives.

Staley Coating Adhesives
Starches and Dextrins give better results for machine or regular brush coating.

Staley Plasticizers
"Sweetose"® and Staley's corn syrup are ideal softening agents for glassine paper.

A. E. Staley Mfg. Company, Decatur, Ill.



Soya Products Division of Glidden, Chicago—America's vast center of soybean research and processing often referred to as Soybean City.

From SOYBEAN CITY...

Quality Soya Proteins for the Paper Industry

Glidden ALPHA* PROTEIN

Glidden PROSEIN*

Coating papers with this chemically isolated, soya protein adhesive definitely *adds* to their quality. Paper coaters everywhere have learned from experience that it introduces efficiencies which actually lower coating costs! Here are just a few of the unusual properties of Glidden Alpha* Protein which it will pay *you* to know about:

- Glidden Alpha* Protein solution is stable over a wide temperature range.
- Glidden Alpha* Protein is compatible with the various pigments used and binds them to the fiber of the raw stock easily.
- Glidden Alpha* Protein adhesive does not affect, to any extent, the brightness of the pigments used or their hiding power.
- Glidden Alpha* Protein alkaline-cut adhesive permits addition of formaldehyde to coating colors to make the finished paper water resistant.
- Glidden Alpha* Protein adhesive is free-flowing at a low water ratio.
- Glidden Alpha* Protein adhesive keeps pigments or other insolubles more uniformly suspended—prevents formation of hard, difficult-to-disperse masses.
- Glidden Alpha* Protein adhesive sets quite rapidly and dries easily without undue shrinkage or interference with the finish when the paper is calendered.

A mechanically refined soya protein adhesive, Prosein* is preferred for reasons of economy in cases where certain outstanding qualities exclusive to Alpha* Protein are not required. Compatible with Alpha* Protein and other alkaline-cut protein adhesives in all proportions. An efficient adhesive for many uses.

★ ★ ★

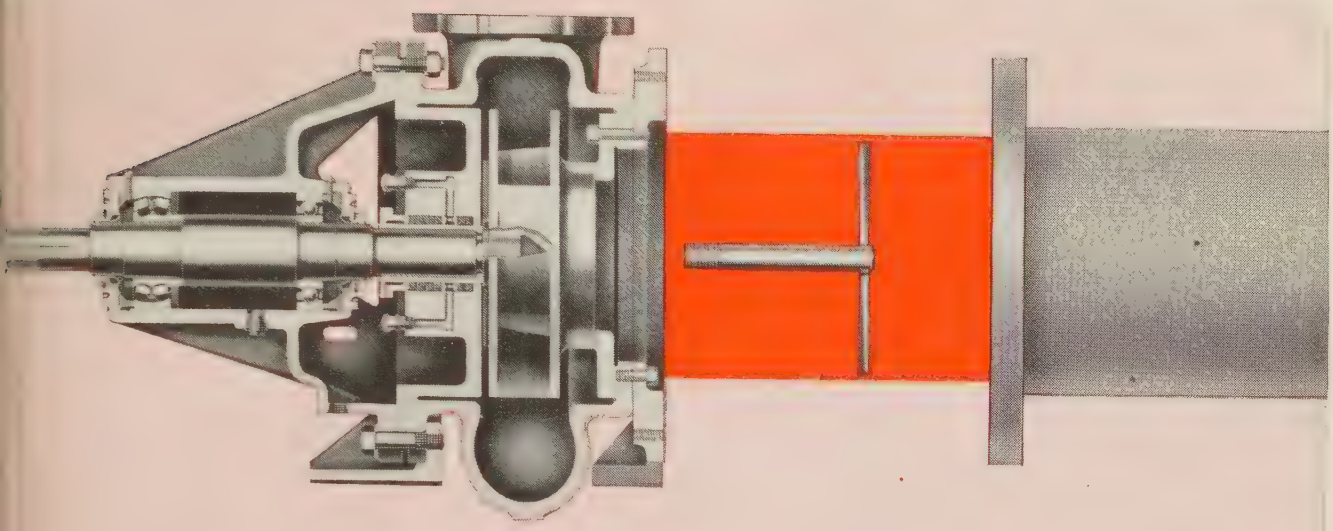
In its completely equipped Service Laboratory, staffed by experts on all phases of paper processing, Glidden will test the use of its soya protein materials using *your* type of paper according to whatever procedure *you* specify. On the results of such testing, we feel confident you will want to join the steadily growing number of paper coaters using Glidden soya protein adhesives exclusively.

*Trade Mark Registered

The Glidden Company
SOYA PRODUCTS DIVISION
1825 N. Laramie Avenue, Chicago 39, Illinois

QUALITY Glidden PRODUCTS

Relieves Suction Problems in Pumping Heavy Stocks



PW Pump with 16 inch Suction + Feeder Vane Assembly + Large Suction Piping

STOCKS UP TO 6% HANDLED WITH EASE; HEAVIER STOCKS UNDER SOME CONDITIONS

YOUR SUCTION PROBLEMS in handling heavy stocks can be greatly reduced by the use of an Allis-Chalmers Paper Stock Pump with 16 inch suction opening. This means that you can take full advantage of the economy of handling stock at the highest possible consistence.

Increased NPSH

Allis-Chalmers has developed a paper stock pump with a full 16 inch suction opening for discharge openings from 4 to 12 inches. This means absolute minimum friction loss right up to the eye of the impeller. Available Net Positive Suction Head is increased. In addition, a feeder vane assembly is available to further improve suction conditions. The action of the feeder vane as it rotates with the impeller moves the stock into the eye of the impeller, increasing the NPSH at this critical point.

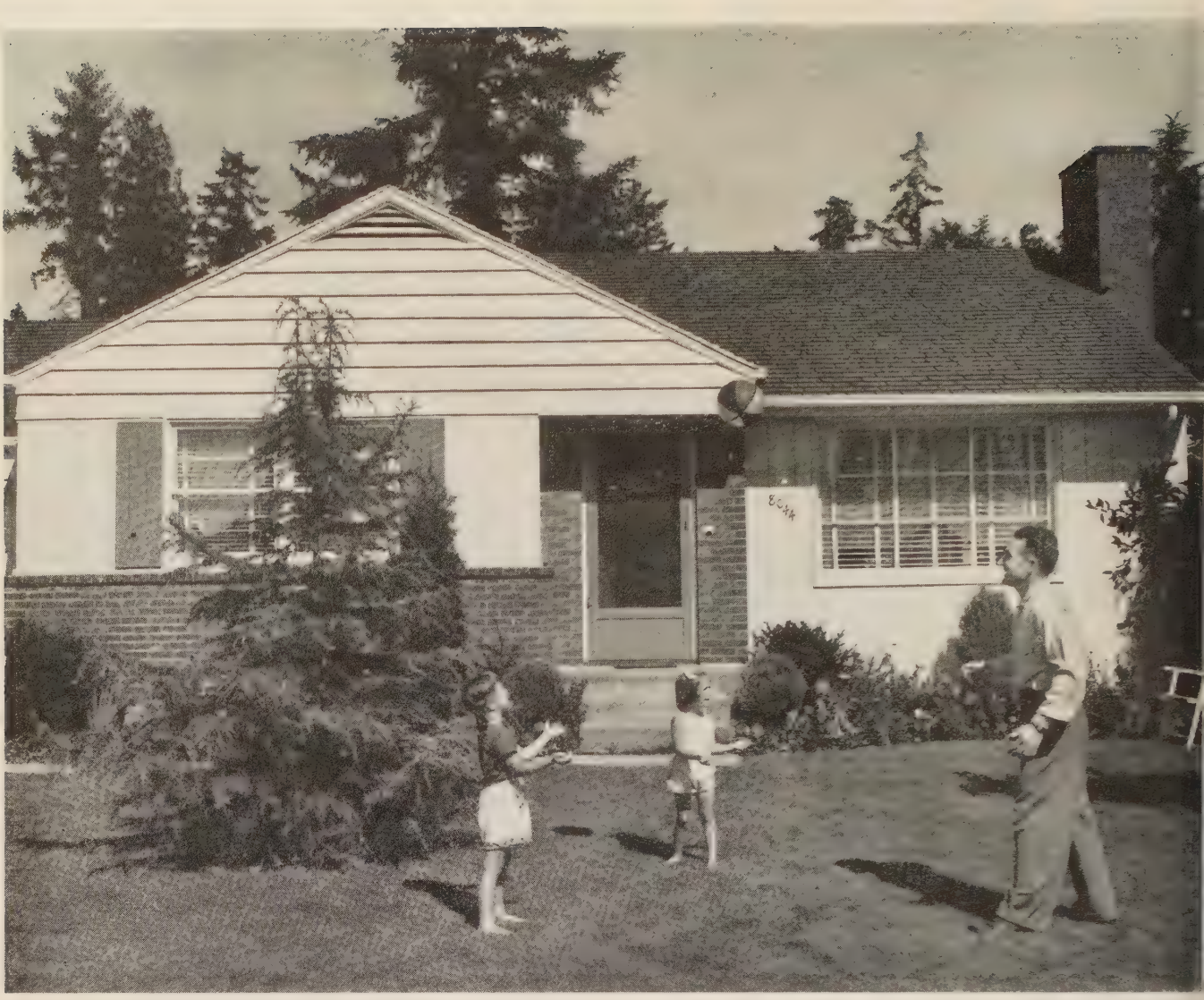
Handles 6% Stock

With the feeder vane assembly, this Allis-Chalmers Paper Stock Pump is successfully handling stock up to 6% consistence, and under favorable conditions even heavier stocks.

For information on how this pump can help you, and the assistance of an experienced paper mill pump engineer, get in touch with your Allis-Chalmers District Office or write for Bulletin 52B7112. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3905

ALLIS-CHALMERS



Would Ivan live in this "house of cards"?

Chances are Ivan would just love to move into a house like this . . . if he could manage it. But, of course, he couldn't afford it. Too, his country can't begin to match ours in production of one of the important ingredients of this house—4′x8′ "cards" of wallboard, a product of our giant pulp and paper industry.

Wallboard is only one of dozens of ways in which our American paper makers have helped make our life better. Others are: Paper facial tissues, paper shipping cartons, paper milk containers, and many additional applications of paper and pulp products which offer improvements on older methods.

We of Pennsalt proudly salute the paper and pulp industry in its gigantic project of making paper meet the various needs of our country in any way that paper might serve. And we are pleased that our chlorine, caustic soda, hydrogen peroxide and corrosion-resistant cements are helping the great paper industry.

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Progressive Chemistry for Over a Century

DU PONT PIGMENT COLORS

for

- **WALL PAPER**
- **COATED PAPER**
- **FLINTED PAPERS**
- **BEATER DYEING**

STANDARDIZED PIGMENTS TO MEET THE EXACTING REQUIREMENTS FOR PAPER COLORING

THE DU PONT LINE includes economical pigments of highest quality. There are colors for beater dyeing which have been especially processed for quick and thorough dispersion in water. They have better strength than the usual lakes for beater coloring. Use them for papers which must have good lightfastness.

All these Du Pont pigments are standardized for properties important to their use in paper. They may be adapted to the most exacting requirements.

You can get further information from your Du Pont salesman, or by writing to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 1007 Market Street, Wilmington 98, Delaware.

USE THESE DU PONT PIGMENTS FOR QUALITY PRODUCTION

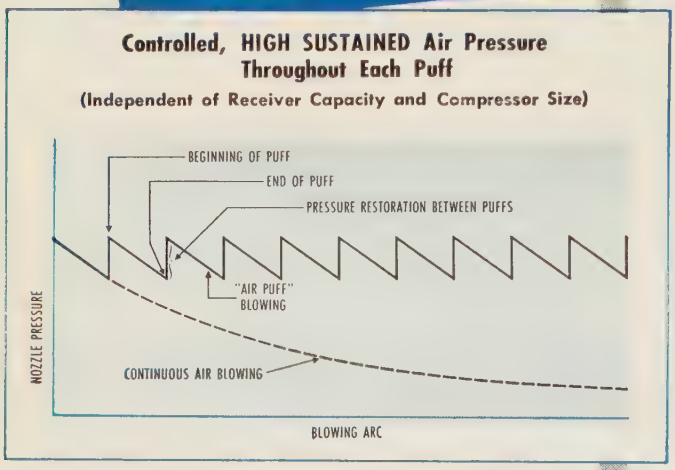
Chrome Yellow • Organic Yellow Lakes • "Watchung" Red
Pigment Green B—full strength and lakes • Molybdate Orange
Dispersible "Monastral" Blue and Green Lakes • Toluidine Red
PTMA—Green and Red Lakes

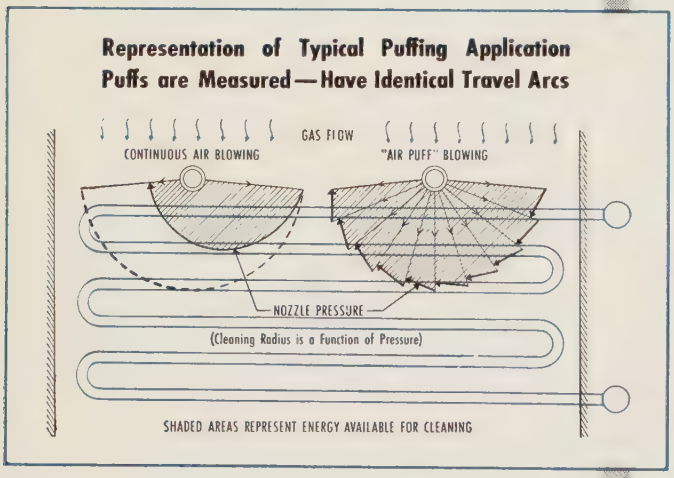
DU PONT

Better Things for Better Living

DU PONT
PIGMENTS
FOR PAPERS

Why the Diamond Automatic "AIR PUFF" Principle of Soot Blowing means Cleaner Boilers at Lower Costs

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CONTINUOUS AIR BLOWING
"AIR PUFF" BLOWING
NOZZLE PRESSURE
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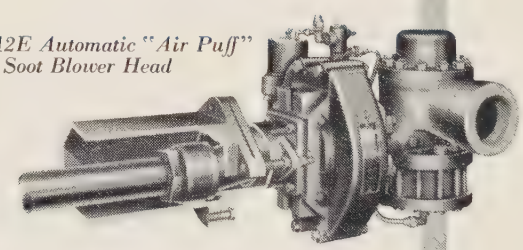

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The Liquid Ring Compressor—Some Thermodynamic Characteristics

HAROLD E. ADAMS

The liquid ring compressor and vacuum pump is extensively used in the papermaking industry but its essential nature and unique features are often overlooked. In this paper the basic operating principle is explained and the unusual thermodynamic characteristics resulting from the intimate mixing of the gas or air with the spinning liquid ring are indicated, such as the near isothermal effect and evaporative cooling and the condensing characteristics. It is also emphasized that liquid ring pumps cannot be rated on a displacement basis but are tested with air using water as a seal under a standard set of temperature conditions and rated in terms of actual delivered capacity. Any material change from these conditions influences the pump's performance. Particular emphasis is laid on the gain in capacity that can be realized when taking full advantage of the condensing effect between the liquid ring and the saturated mixtures usually encountered in paper machine applications. A typical couch roll installation is analyzed and complete calculations presented which illustrate this prevalent though generally unrecognized effect of condensation. A gain of 23% in capacity over standard rating is shown in this example. Data are presented to estimate the increased capacity over standard rating on conventional paper mill applications. The possible gains in operating efficiency by attention to water seal temperature and quantity are stressed.

EVERYONE is familiar with the principles of the reciprocating vacuum pump or compressor. The positive rotary pump and the centrifugal compressor are almost equally understood, although the latter is more involved. Very little technical information, however, has been published on the liquid ring type vacuum pump and compressor. The tendency, therefore, is to think of this type of unit in terms of the more familiar types, and, as a result, the real nature of the pump is obscured.

The purpose of this paper is to bring out the fact that the liquid ring pump is in a class by itself and should be rated and applied under considerations applying to its own class. More specifically, this paper will emphasize the thermodynamic characteristics of the liquid ring vacuum pump, particularly as applied to its use in the papermaking industry.

GENERAL DESCRIPTION

The liquid ring pump is not new. It has been in use both here and abroad for many years and is firmly established in numerous fields. There are some, however, who have not had experience with it and for their benefit, a general description of the operating principle of a popular type is given.

A multiple bladed rotor, the only mechanical moving part, spins a ring of liquid within an elliptical casing to provide the displacing means for pumping and compressing gas.

The elliptical casing X is shown in Fig. 1, with its major axis at AA and its minor axis at BB. The rotor operating at the center of the ellipse has forward curved vanes V, fitted with side shrouds (not shown), forming a series of rotor chambers such as 1 through 10, open at the inner and outer diameters.

The inner diameter openings of the rotor turn concentrically about a central stationary tapered plug or port member, which has fixed gas inlet and gas outlet ports, S and T, respectively. This plug also has intermediate sealing surfaces L and G between the ports which seal off the inner openings of the rotor as they pass around from one port to the other. Suitable conduits connect the two inlet and two outlet ports to the external air inlet and outlet connections on the casing.

The direction of rotation, which in this case is clockwise, is indicated by the arrow. The formation and general shape of the spinning liquid ring R are indicated on this diagram.

In a lay explanation of the operation of this pump, the chambers formed by the rotor blades may be considered as rotating displacement cylinders and the segment of the revolving liquid ring accompanying each chamber may be likened to a liquid piston. The eccentric path of the revolving liquid ring produces an out and in, or reciprocating radial motion to each liquid piston relative to its rotor cylinder which revolves about the fixed center. The displacing action caused by these reciprocating liquid pistons first draws air into the rotor cylinder through a central inlet port and then compresses and finally discharges each cylinder of air through a central discharge port.

This may perhaps be better understood by considering a complete pumping cycle. Starting at position 1, at the minor axis of the ellipse, it will be noted that the liquid piston completely fills the displacement chamber 1. As this particular chamber rotates to positions 2, 3, and 4 the liquid piston is progressively thrown outward by centrifugal force as it follows the general pattern of the liquid ring within the elliptical casing. This outward stroke of the liquid piston draws gas into the rotor chamber through the inlet port S.

As the rotor revolves the chamber to positions 5 and 6 the liquid ring is traveling through the major axis of the casing where the liquid piston has attained its full outward stroke. During these and the immediately following positions, the inner opening of the displacement chamber is sealed off from the ports by the cone sealing surface G. The outer openings of the rotor chamber are always sealed by the liquid ring.

HAROLD E. ADAMS, Vice-President and Chief Engineer, The Nash Engineering Co., South Norwalk, Conn.

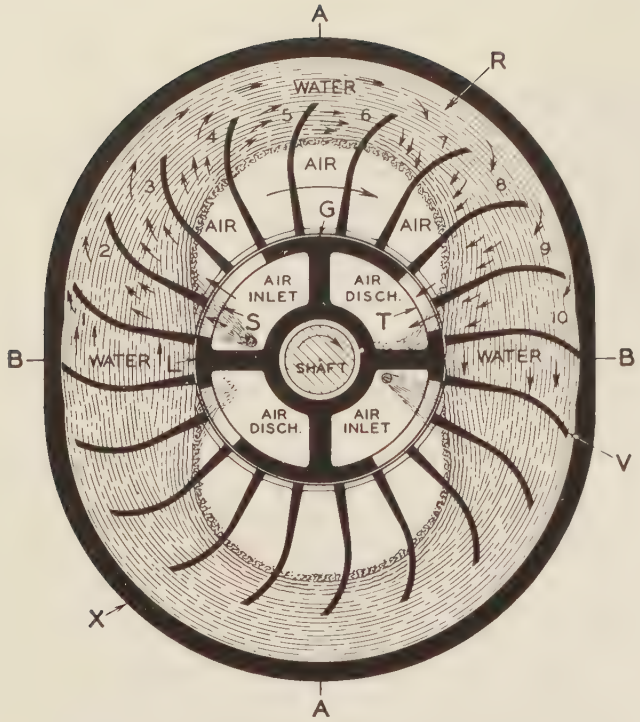

Fig. 1. Liquid ring operating principle

It will thus be observed that each chamber as it passes the major axis carries its maximum volume of trapped air. The continued turning of the rotor carries the displacement chamber through positions 7, 8, 9, and 10 where the revolving liquid ring is being forced back into its displacement chamber thus causing the progressive compression of the trapped air in the chamber and its final discharge through port T.

This same cycle is repeated through the other half of the rotation thus giving symmetrical operation and assuring radially balanced forces on the rotor, shaft, and bearings. Each displacement chamber of the rotor makes two cycles or complete discharges of air per revolution. When we consider the number of rotor chambers, the number of revolutions per minute made by the rotor, and multiply the product of these by two, we obtain such frequency of discharge as for all general purposes amounts to a continuous flow without pulsation.

It is interesting also to note that this unit has a variable displacement characteristic which permits the compression of the trapped air up to final pressure before the opening of the discharge port. This characteristic coupled with design variations of the elliptical path, and the ports, permits the construction of pumps for specific compression ratios.

In actual operation, the liquid ring is continuously being renewed. Make-up liquid or seal, as it is hereafter called, is admitted at the inlet or other appropriate place in the pump, and a corresponding amount is discharged with the compressed gas. This liquid is removed from the discharged gas by a baffle or centrifugal type separator. This seal serves as a most effective cooling means to remove some of the heat of compression. Large additional quantities of liquid can be handled through the compressor or vacuum pump by the use of an unloader or liquid by-pass.

Single stage liquid ring pumps of modern design can operate up to 26 in. vacuum, or as a compressor to lb. gage pressure. They may also be operated staged relationship over higher compression ratios.

There are numerous other constructions of liqu ring pumps, such as single eccentric lobes, straig bladed rotors, and differences in the port and lobe rangements, but the previous explanation covers most popular type in use in this country.

Having reviewed the general principles of this pun let us explore some of its less understood features.

THE LIQUID RING

We have seen that the principal element of compr sion is the revolving ring of liquid. The shape or fo that this ring assumes is dependent upon the speed rotation, the contours of the casing and rotor blad and the work of compression imposed upon it. It d not describe a pattern that can be clearly defined measured and hence the pump cannot be rated in ter of swept volume or positive displacement, as is the c with reciprocating or rotary positive type pumps.

It is, on the other hand, relatively positive in action when compared to a centrifugal gas compress This is because it is the heavy, confined, fixed dens liquid ring that is centrifugally acted upon instead the light, compressible, variable density gas itself, as a true centrifugal gas compressor.

Inasmuch as it is the liquid ring that does the work virtue of kinetic energy, the amount it can do is limit principally by its density and rotational speed wh are preselected for the work range required. serious harm or excessive power is built up if the d charge valve is throttled or closed. This is because the nonpositive nature of the spinning liquid piston.

Thus we see that although centrifugally operated, eccentric liquid ring gives a semipositive operat characteristic to the compressor. We have, in effec centrifugal liquid pump whose output is convertec pumping and compressing a gas instead of deliver the liquid itself to the higher pressure.

Liquid Ring—Gas Reactions

There are many interesting interchanges taking pl between the working liquid ring and the gas or vap These reactions require some consideration in the plication of this unique compressor. It is indeec veritable thermodynamic and chemical laborat wrapped up in one package. Such reactions give t unit a multitude of characteristics that still further it apart from conventional positive or centrifugal t compressors.

It would require a large volume to attempt to co the many applications where liquid ring vacuum pur or compressors can be used to special advantage. experienced manufacturer of this equipment can bes approached for possible uses. This paper will principally with their thermodynamic characteristic importance to paper mill use.

Cooling Functions

One of the first and most obvious thermodyna functions of the liquid ring is that of cooling. I truly a liquid cooled compressor. The large volum cooling liquid is in direct contact and is intima mixed with gas or vapor being compressed. The m

m of heat transfer to the liquid is therefore obtained. his is contrasted to the conventional cooling of water- keted compressors where the heat transfer through e cylinder walls is necessarily less effective. The uid ring compressor or vacuum pump can achieve ctically isothermal compression as compared to the ytropic compression of water-jacketed machines or near adiabatic compression of uncooled blowers or o-compressors.

As an example of the approach to isothermal compres- of the water ring vacuum pump, the temperature when working single stage at 22 in. vacuum is ap- imately 4°F., whereas, in an uncooled, adiabatic pression machine, the temperature rise would be t 200°F., or even higher. This isothermal char- ristic has many advantages where cool air is re- ed, or where it is desired to recover most of the heat ompression in the cooling water which in turn can sed in the plant process.

vaporative cooling also takes place in the liquid pump especially when handling relatively dry air or This limited type of cooling is sometimes used in tive type compressors in the form of an inlet spray. cooling effect is limited, however, to the small unt of liquid that can be evaporated in the com- ssion cycle. An excess of liquid spray beyond what be evaporated might cause excessive power or dam- to a positive type compressor, whereas, the liquid g pump by its nature easily handles excess liquid. aporative cooling, of course, is less effective when ndling air or gas initially saturated with the coolant por.

When pumping a gas or air saturated with vapor at a gher temperature than the seal, the opposite to evapo- tive cooling takes place in the liquid ring pump. is an effective condenser in such cases. This condens- g advantage will be explained in detail later in this per.

The liquid ring vacuum pump or compressor by vir- e of the direct action of its liquid ring, therefore, is turally adapted for maximum cooling by sensible at transfer, by evaporative cooling, and by condensa- n.

pacity Rating of Liquid Ring Pumps

We have noted earlier in this paper that the liquid g pump does not have a definite swept volume that n be measured and referred to as a basis for rating in rms of displacement, as is the practice with positive placement pumps.

The only way it can be rated is on the basis of actual t delivery as established by test, and this method was pted early in the development of these pumps in s country. Air measured by means of the square- ed orifice is used as a standard calibrating means and this connection high differential square-edged orifice equipment was developed specifically for test pur- s.

The rating tests had to be run under, or corrected to, tandard set of operating conditions. In the case of vacuum pump, 60°F. water was adopted as the ndard seal and the air used in measuring capacity s established as atmospheric air at 60°F. of 50% tive humidity expanded through the orifice to the ed vacuum. Capacity was expressed as cubic feet of air at this vacuum and temperature. The small amount of vapor in this mixture amounted to less than 1% by volume at 22 in. vacuum, leaving over 99% dry air entering the pump under the standard rated condition. For the remainder of this paper this test air is considered as 100% dry air. It should be emphasized that the liquid ring vacuum pump's standard capacity rating is in effect an actual tested capacity occurring under this specific set of conditions.

If the conditions of the application differ much from these standards, the pump's capacity under the new conditions can be determined by appropriate calculations. The actual capacity may vary considerably from standard, if the service conditions differ greatly, as will be shown later.

Deviations from Standard Rated Conditions

There is the general knowledge that the liquid ring pump capacity is affected by its seal temperature. It is quite obvious, when you think of it, that the maximum vacuum it can attain is limited by the vapor pressure of the liquid in the ring. When the pump reaches an inlet absolute pressure equal to the vapor pressure of its seal, this is as far as it can go. The importance and relationship of the water seal vapor throughout the full operating range of the vacuum pump are less generally known.

The percentage of seal vapor in each pumping chamber in general follows the proportions that would be expected by Dalton's and Amagat's Laws. According to the latter, in a mixture of gas and vapor, each one occupies a given space in proportion to the ratio of its own partial pressure to the total pressure of the mixture. In a water ring vacuum pump operating with normal seal, the temperature rise of the water ring in doing the work of compression averages about 4°F. When the relatively dry air enters the inlet displacement chamber of the rotor, it immediately comes in contact with the initial 60°F. inlet seal water and the 64°F. water in the liquid ring. It may be assumed that the average water temperature at the inlet position of the displacement chambers is 62°F.

The time interval during the inlet stroke is so brief that full saturation does not occur but we can assume that the space is 50% saturated at the inlet vacuum and at 62°F. The partial water vapor pressure at the inlet, therefore, would be one-half of the full vapor pressure for 62°F., or 0.28 in. Hg. At 22 in. vacuum, or an absolute pressure of 29.92 in. −22 in. = 7.92 in. Hg, the water vapor would occupy (0.28 in. × 100)/ 7.92 in. = 3.5% of the total volume. This would leave available 96.5% of the pump's displacement for intake of dry air. It is this 96.5% of the pump's available displacement that is indicated as its net air capacity in all standard performance curves and ratings.

Figure 2 is given to show the relative percentages of dry air and water vapor in the pump inlet chambers for 60°F. initial water seal temperature when handling 60°F. dry air.

If the air entering the pump inlet is already saturated with water vapor at an equal or higher temperature than the seal, there is no evaporation or flashing of the water in the ring at the inlet stroke. This is because the space is immediately filled by the incoming mixture with water vapor at a pressure equal to or above the vapor

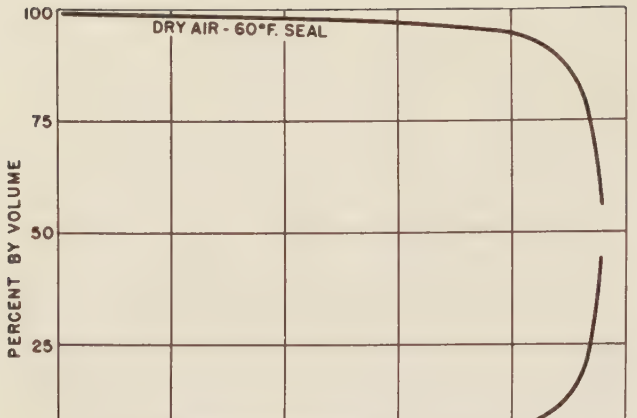

Fig. 2. Proportion of air and vapor in pump inlet displacement chamber when pumping dry air

pressure of the water in the ring. The whole net displacement of the inlet bucket in this case is available for the handling of the entering saturated mixture. The seal itself cannot evaporate to take up some of the space as in the case with entering dry air.

Thus the water ring pump when handling air saturated at the seal temperature has a higher net cubic foot capacity than is indicated by its standard performance curves. At 22 in. vacuum, for instance, the 3.5% taken up by the water vapor of the ring under standard dry air test conditions represents additional displacement that is available for handling air that is already saturated. This means that the standard curves at 22 in. vacuum only indicate 96.5% of the capacity the particular pump can handle when the mixture is already saturated at the average seal temperature.

Expressing it another way, a factor of 1/0.965 or 1.04 should be applied to the standard pump rating at 22 in. vacuum to obtain its true capacity when handling a saturated mixture of the same average temperature as its seal.

If the temperature of an entering saturated mixture is higher than the average temperature of the water ring, the latter then acts immediately to condense some of the vapor in the entering mixture. The effect of this condensation is to reduce the volume of the mixture as it enters the pump displacement chambers. This reduction in volume is a further net gain in over-all capacity for the pump. It may amount to a very considerable increase over the standard rated capacity. This latter condition is most generally the case when the liquid ring pump is working on paper mill applications and a more specific example of the condensing effect will be illustrated under this topic.

PAPER MILL APPLICATIONS

The greatest use of these machines in the paper industry is, of course, as a vacuum pump applied to flat boxes, suction couch and press rolls. Here its trouble-free, 24-hr. service has long been accepted and recognized. As the size and speed of paper machines have increased, the liquid ring vacuum pump has kept pace in size, range, efficiency, and design.

The industry, as a whole, however, is prone to think of this type of equipment merely as the reliable work horse it has been over the years. A little more atte tion to its latent possibilities should pay good dividend Part of the object of this paper is to overcome the ten ency of conventional thinking generally given to thes pumps and to stir interest in their real nature and po sibilities. With a better understanding of liquid rin pumps, they may more effectively be applied and ap preciated on the increasingly exacting requirements modern paper machines.

In the daily use of these pumps it is quite often ac cepted that a certain size and type of water ring pum will give a satisfactory vacuum under a given set stock and operating conditions. A further step is to as sociate the catalog standard capacity of such pump with the requirements of the paper machine. The im plication is that it takes this indicated capacity to d the job. From what has already been presented in thi paper it is quite evident that the actual capacity re quired is most likely something quite different from th pump's capacity under its standard rated set of cond tions. The temperature of the stock, the temperatur and amount of the seal water supply, are important con ditions that modify the pump's actual performance o the job. It would seem, therefore, that a more con sidered approach should be made to the pump specif cation.

The question of the effect of increased stock tempera ture on pump requirements to maintain a given vacuu in itself is a most important study. It would seem highly desirable to be able to express the pumping re quirement in definite terms of actual cubic feet of ai vapor mixture to be removed at a given temperatu and vacuum, rather than loosely specifying this require ment to what a given size of pump known to perfor satisfactorily under a somewhat similar conditio would do.

It is indicated, also, that considerable attentio might be given to a more realistic understanding paper machine vacuum and temperature conditio themselves as a parallel benefit to the better unde standing of the application and performance of th liquid ring vacuum pump to these machines.

This paper will not go into details as to machi operating conditions other than as needed for bac ground to illustrate the nature of the thermodynam processes involved in the pumping operation with liquid ring pump.

A Typical Paper Mill Application

The suction applied to a couch roll suction b brings forth a saturated mixture of air and water vap which must be continuously removed to maintain t vacuum on the roll and exert the desired drying effe In the past, the full nature of this saturated mixture h received relatively little attention because it has be adequately handled by the application of sufficie vacuum pumps to produce the desired vacuum. recent years, however, the trend in papermaking h been to higher stock temperatures and higher vacuu on the suction boxes. Every increase in vacuum temperature carries the mixture that the pump mu handle farther afield from the relatively dry standa air mixture which is used in rating the pump capacity.

Let us examine the nature of a typical mixture or couch roll with stock temperature at 120°F. and with

vacuum at the roll of 21.5 in. Hg referred to a 29.92 in. barometer. In this case, the total absolute pressure in the box is 8.42 in. Hg. The partial vapor pressure for 110°F. water is 3.44 in. Hg absolute. The partial air pressure is 8.42 in. −3.44 in. = 4.98 in. Hg absolute. The dry air content of this mixture, according to Dalton's Law, is (4.98 in. × 100)/8.42 in. = 59.3% leaving 40.7% as water vapor.

The nature of the saturated mixture withdrawn from the couch roll, particularly at elevated temperatures, with its high vapor content, would suggest the possibility of using condenser practice, if practical. The percentage of air, however, is too great to apply a condenser efficiently, and the size and cost of the structure would be excessive. But we can, and in most cases are, unknowingly taking advantage of the condensing action in the water ring vacuum pump. This pump, by its nature, is a combined condenser and large volume air pump. When so applied it performs a duty cycle which is quite different from its normal rated performance.

Suppose we go back to our previous example and assume that there has been a 10°F. drop in temperature and 1/2 in. mercury drop in pressure from the couch roll to the vacuum pump inlet. In this case, we have a saturated mixture entering the pump inlet at 22 in. vacuum and 110°F. Under these conditions, the total pressure is 29.92 in. −22 in. Hg vacuum, or 7.92 in. Hg absolute, the vapor pressure of the water is 2.59 in. Hg absolute, leaving a partial air pressure of 5.33 in. absolute. The air content of our mixture is now (5.33 in. × 100)/7.92 in. = 67.3% dry air, leaving 32.7% water vapor.

In problems of this nature, it is best to determine the air content of the mixture in pounds of air. The pounds of air, of course, remain constant throughout all the temperature and pressure changes, and by the application of the well-known gas law $PV = MRT$, and Dalton's law of partial pressures, we can determine the volume of the mixture in any set of conditions throughout the pumping cycle.

Referring again to our example, if we assumed that the mixture had arrived at the pump inlet at the 22 in. vacuum, 110°F. condition and that 1000 c.f.m. of this mixture was required to be removed at this point in order to maintain the 22-in. vacuum on the couch roll, we would apply this formula:

$$PV = MRT$$

where

V = volume, c.f.m. (1000)
M = total weight of dry air in pounds per minute in the saturated mixture
R = constant for air = 53.3/(144 × 0.491) = 0.754
T = absolute temperature °F. = 460°F. + 110°F. = 570°F. absolute
P = Partial air pressure in. Hg = (29.92 − 22.0) − 2.59 = 5.33 in. Hg

Substituting in the formula:

$$M = \frac{VP}{RT} = \frac{1000 \times 5.33 \text{ in.}}{0.754 \text{ in.} \times 570} = 12.4 \text{ lb. per min. dry air}$$

After passing the inlet connection of a water ring vacuum pump, the saturated mixture comes in contact with the relatively cooler entering seal water and immediately thereafter is thoroughly mixed with the cooler water ring itself. The intimate contact with this cool water in the pump immediately condenses a portion of the vapor of the entering mixture thus reducing the over-all mixture volume as it enters the displacement chambers of the pump. The relatively large body of the liquid ring and the large amount of water that is continuously circulated through it cause only a small increase in the water ring temperature even though considerable condensing of the incoming vapor is accomplished.

Let us assume in this example that the entering seal water temperature is 80°F. which is a relatively high seal water temperature. From tests with water ring pumps under similar conditions of inlet mixture and inlet seal temperature, it has been observed that the resulting discharge temperature of the water ring after condensing some vapor and after absorbing some of the heat of compression is approximately 93°F., or a 13°F. rise. This temperature rise may vary within small limits depending upon the amount of seal water used with the pump.

The intimate mixing of the 80°F. make-up seal water and the 93°F. water in the ring with the incoming 110°F. saturated mixture immediately condenses some of the vapor in the latter. The temperature of the mixture is therefore reduced as it enters the rotor displacement chambers to an intermediate value between the 110°F. inlet and the 93°F. outlet seal temperature.

This intermediate temperature can be determined by test. For couch roll applications this temperature is the average of the initial mixture temperature and the entering seal temperature for vacuums up to 21-in. Hg, and for higher vacuums, 2°F. is added to this average temperature for each inch of vacuum above 21 in. Hg.

The above defined intermediate temperature applies to the saturated mixture existing within the initial rotor displacement chambers. The volume of this mixture can be determined by applying Dalton's law, the steam tables, and the basic gas formula.

The intermediate temperature for the example is the average of 110°F. + 80°F. or 95°F., plus 2°F., or 97°F. The vapor pressure for 97°F. is 1.76, which subtracted from the total pressure of 7.92 in. Hg absolute gives a partial air pressure of 6.16 in. Hg absolute. Applying the basic gas formula to this new condition, the volume of the mixture is (12.4 × 0.754 × 557)/6.16 = 845 c.f.m. This 845 c.f.m. is the actual net volume that the pump has to handle.

The shrinkage in mixture volume from 1000 to 845 c.f.m. is a result of the condensation of some of the water vapor content of the mixture occurring within the water ring pump from the time it enters the inlet connection up to the time it reaches the inlet displacement chambers. A review of the amount of vapor so condensed versus the total heat gained by the liquid ring would serve as a check on the ability of the water ring to condense this amount within the 13°F. rise previously cited.

The water vapor present in the original 1000 c.f.m. of mixture may be calculated as follows, using steam table values:

Specific volume for 110°F. = 265.5 cu. ft. per lb.

Total pounds water vapor per 1000 c.f.m. mixture =

$$\frac{1000}{265.5} = 3.77 \text{ lb. per min.}$$

The water vapor present in the inlet displacement chambers of the rotor is determined from the following values:

Specific volume for 97°F. = 382 cu. ft. per lb.

Total pounds water vapor in the inlet mixture =

$$\frac{845}{382} = 2.21 \text{ lb. per min.}$$

The water vapor condensed by the pump sealing water is 3.77 − 2.21 = 1.56 lb. per min.

The average latent heat of condensation for steam at these pressures is 1035 B.t.u. per lb. In order to condense 1.56 lb. of water vapor per min. there must be a heat transfer of 1.56 × 1035 = 1615 B.t.u. per min. to the seal water.

A pump of the size required for this example would take about 42 g.p.m. of seal water. In this case it is supplied at 80°F. Under standard test conditions, it would rise 4°F. to take care of the heat of compression, but in this case, where it handles condensable vapors, it has been stated the water ring temperature would rise 13° to 93°F. The rise from 84 to 93°F., or a 9°F. rise, is available for condensing. A 9°F. rise in 42 g.p.m. would absorb 42 × 8.3 × 9 = 3140 B.t.u. per min. The 9°F. temperature rise, therefore, is more than sufficient to take care of the required heat transfer of 1615 B.t.u. per min. The difference is taken up in further condensation through the compression cycle to the final 93°F. value.

Selection of Proper Size of Pump

The next problem is to select a water ring vacuum pump from standard test performance data that will be properly sized to handle the 1000 c.f.m. saturated air of the example.

We have noted that the pump has to handle a net displacement of 845 c.f.m. of mixture at 22 in. vacuum in order to pump this 100 c.f.m. The 845 c.f.m. is a completely saturated mixture, whereas, the standard test data give performance when handling dry, unsaturated air. Correction, therefore, must be made to the standard curve. It was indicated previously that at 22 in. vacuum under standard conditions, the net dry air rating of the pump was 96.5% of its total available displacement capacity. It was furthermore observed that when handling a saturated mixture at the average inlet seal temperature and at 22 in. Hg vacuum, a correction factor of 1.04 should be applied to the standard performance capacity rating to give the actual saturated air capacity.

The net capacity of 845 c.f.m. of saturated mixture, therefore, when referred to standard rating, would be 845/1.04 = 812 c.f.m. standard capacity.

We would, therefore, refer to standard rated performance data and pick a pump at 22 in. vacuum that had a capacity of 812 c.f.m.

This 812 c.f.m. is theoretically and actually the standard rated capacity of a water ring vacuum pump that should be specified to pump a net 1000 c.f.m. of 110°F. saturated air at 22 in. vacuum when the pump is supplied with its normal quantity of seal water at 80°F.

General Application of Condensing Effect

In the case of the typical application just worked out, if the required capacity had been specified in terms of

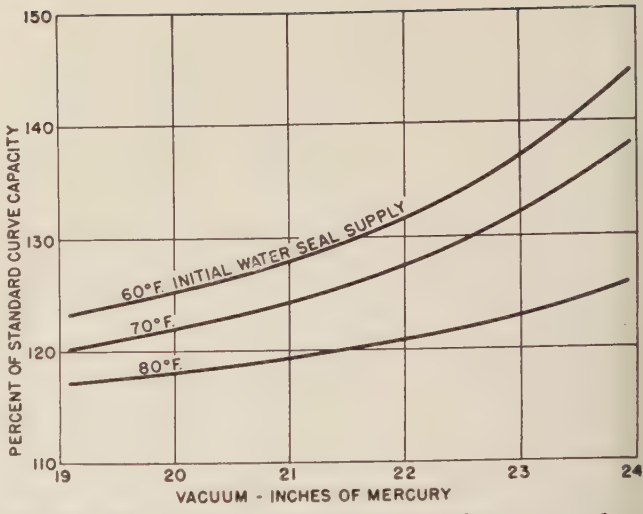

Fig. 3. Water ring vacuum pump performance when pumping saturated air at 110°F.

cubic feet per minute of net capacity, we could apply a water ring pump with a standard rating of (812 × 100)/1000 or 81.2% of this capacity. If we were evaluating the performance of a liquid ring pump operating on an installation of this nature, we would find its actual capacity by multiplying the standard rated capacity by (1000 × 100)/812 or 123%.

Figure 3 shows the percentage of standard rated capacity that can be expected when using water ring pumps on 110°F. saturated air mixtures under varying seal supply temperatures. This curve is based upon careful pump tests made with saturated air under closely controlled laboratory conditions.

The operating net capacity of water ring vacuum pumps on your existing installations can be roughly approximated by use of Fig. 3 if conditions coincide. For other mill conditions, the following procedure may be followed to obtain a multiplying factor F, which when applied to the pump's standard rated capacity will give approximately its actual capacity on the particular installation:

A. Determine following values by direct observations and by reference to standard steam tables:

- P_1 = absolute inlet pressure, inches Hg at inlet of pump = (barometer—vacuum inches Hg at pump)
- t_1 = temperature of saturated mixture at pump inlet, °F
- T_1 = temperature of the saturated mixture at pump inlet degrees absolute = t_1 + 460°F.
- PVP_1 = partial vapor pressure of the mixture, inches Hg a pump inlet determined from steam tables at tem perature t_1
- PAP_1 = partial air pressure, inches Hg of the entering mixtur = $P_1 - PVP_1$
- t_3 = entering seal water temperature, °F.

B. Determine the intermediate or rotor inlet mixture tem perature t_2 °F.:

(1) For vacuums from 19 to 21 in. $t_2 = (t_1 + t_3)/2$
(2) For vacuums from 21 to 24 in. $t_2 = (t_1 + t_3)/2 +$ (inches vacuum—21 in.)
(3) T_2 = temperature of saturated mixture at rotor inlet i °F. absolute = t_2 + 460°F.

C. Determine partial air pressure inches Hg at rotor inle PAP_2:

(1) PVP_2 = partial vapor pressure, inches Hg at rotor inle determined from steam tables at temperature t_2
(2) $PAP_2 = P_1 - PVP_2$

D. Determine per cent of dry air A in rotor inlet chamber a the observed vacuum. This value can be taken from upp curve of Fig. 2:

E. Calculate factor F:

$$F = \frac{100}{A}\left(\frac{PAP_2 \times T_1}{PAP_1 + T_2}\right)$$

F. Net saturated air capacity = standard rated capacity multiplied by F

The above empirical formula would apply to most paper mill installations using a normal amount of seal water supply. In some instances better results can be obtained by increasing the amount of seal or by using an auxiliary inlet spray. A survey of your own installation may be very worth while.

This paper has primarily attempted to bring out the unusual thermodynamic characteristics of liquid ring pumps. It is hoped that a better understanding of them will result in improved service to their many users in the papermaking industry.

LITERATURE CITED

Adams, Harold E., "Accurate Air Measurement by Nash Orifice Method."

Received Jan. 2, 1953. Presented at the 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 16–19, 1953.

Protection for an Industrial Plant Connected to a Utility System with Reclosing Breakers

D. F. LANGENWALTER

This paper is intended to serve as an introduction to the topic of relaying the tie between the industrial plant and the utility. This topic is becoming more and more important as utilities and paper mills establish electrical ties for greater continuity of service. The electrical operating problems associated with such tie operation are described and proper relaying is suggested for various operating conditions. Protection is necessary to avoid loss of production and to prevent damage to motors and generators. The reclosing speeds of breakers and various types of relays for sensing electrical disturbances are discussed.

Utilities have found that fast reclosing breakers on their systems enables them to provide greater continuity of power throughout their system and to their customers. Likewise, fast reclosing can provide greater continuity of power to the industrial user, provided that his machinery will not be damaged by the surges of power which occur when a breaker recloses with the synchronous machines out of step with the power system.

The problem discussed in this paper is: if the power company has reclosing breakers on the line feeding the industrial plant, what should the operators of the plant do to have the advantage of little or no interruption of power and still protect his equipment?

The answer is: if the synchronous machines in the plant stay nearly in step, the utility breakers can reclose restoring the flow of power without danger. The conditions which determine whether or not the machines will stay in step differ so widely from plant to plant that a study should be made to decide on the relaying system.

The utility companies use different relaying schemes in their effort to provide good service to their customers in spite of troubles due to lightning and other faults.

Lightning striking the power company lines leading to the plant usually causes an arc to ground from one or more wires in a section of the power line. When a reclosing system is used, the breakers at both ends of the section are tripped by relays cutting off the power and thus allowing the arc to go out. After a definite period the breakers reclose restoring the flow of power. The time required for the arc to extinguish is less than 12 cycles or 0.20 sec. so the interval before reclosing must be at least 0.20 sec. Some power companies use "fast" reclosing breakers which open the line in 3 to 8 cycles and remain open 12 cycles so the total time for the power interruption is 15 to 20 cycles. Other utilities use "slow" reclosing in which the delay varies from 1 to 30 sec.

In the short interval required for arc extinction the motors in the industrial plant hardly have time to change speed at all and consequently when the power comes back on there is no noticeable interruption in any of the production lines. In some cases, however, the motors slow down appreciably even during the short interval which the power is off. Then when the power is restored very large currents flow which may cause torques high enough to twist the shaft of an electric motor or distort the coils. Another problem arises when the power interruption is longer than 12 cycles or 0.20 sec. The plant generators in a given mill may be unable to supply the load in absence of any power from the power system; then the generators may slow down and actually stop due to the excessive load resulting in a complete failure of power at the mill.

The objective of the industrial relaying system, the operating procedures, and controls, is to keep the industrial plant in operation, if at all possible, or to provide a minimum interruption of production consistent with the protection of expensive equipment.

The various types of faults which occur in a utility system in the order of their probability are: (1) one line-to-ground, (2) two lines-to-ground, (3) three phase, and (4) line-to-line faults. Many of the faults involve only one line-to-ground so that during such a fault the other two lines carry a certain amount of power to the industrial user and help keep the system in step.

As a conservative attack on the problem, we can assume that a three-phase fault would occur in the utility system and set up the operating procedure and relaying for the industrial plant to minimize the interruption of production.

D. F. Langenwalter, Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

Where the industrial user is buying power from the utility, the generators in his own plant may not be able to supply all of the plant load.

In any plant having generators, the loads can be divided into essential and less essential groups as shown in Fig. 1. The essential loads are those which should be kept going when the utility power is off such as lighting, power station auxiliaries, and production machines whose shutdown would cause excessive loss. The capacity of the plant generators must be large enough to carry this load. The rest of the loads are considered less essential. The essential loads should be provided with the type of relaying and controls which will not drop out on a momentary drop in voltage. If the plant generators are overloaded when the utility power is interrupted, then nonessential loads should be dropped by a suitable underfrequency, reverse power, or inertia relay. By such an arrangement the generators will carry the essential loads indefinitely. The loads on the less essential feeders can be re-energized manually after the utility power is restored.

Figure 2 shows a plant with one tie line to the utility system while Fig. 3 shows a plant supplied by two lines. The double line provides much better service since the chances that both lines would be out are rare. When a fault occurs on one line, the power to the industrial plant is reduced only for the 5 to 8 cycles required for the relays to operate and the breakers to clear the fault. When only one line is used the power is interrupted for at least 15 to 20 cycles.

A synchronism check relay or undervoltage relay should be used across the power company breakers A to G to prevent reclosing with the system out of step. These relays would not allow reclosing in the case where both lines were out and the industrial plant slowly drifted out of step.

METHODS OF OPERATION

Table I lists three possible operating procedures for the industrial operator in the event of interruption of power from the utility. Considering the system shown in Fig. 2, breaker A is assumed to reclose in about 20 cycles. Other procedures are possible, but most of them would cause a longer outage and therefore greater loss of production than these.

Table I. Possible Operating Procedures

1. Keep the industrial breaker B, Figs. 2 or 3 closed and make no provision for time delay undervoltage tripping of nonessential load. Allow the utility tie (breaker A, Fig. 2) to reclose picking up whatever load has not been disconnected by undervoltage relays.
2. Keep the breaker B closed and drop the nonessential load by opening breakers D, E, and F. Allow breaker A to reclose on essential loads. Manually restore the nonessential loads on feeders D, E, and F.
3. Open breakers B, C, D, E, and F simultaneously. Manually close breaker B and restart motors on feeders D, E, and F. Manually resynchronize at breaker C.

The first procedure, if successful, gives no interruption in production. With fast reclosing breakers, there is a momentary flicker of lights which passes practically unnoticed. If there are two tie lines to the utility as in Fig. 3 and the fault occurs on only one of them, then power comes from the utility down the second line and

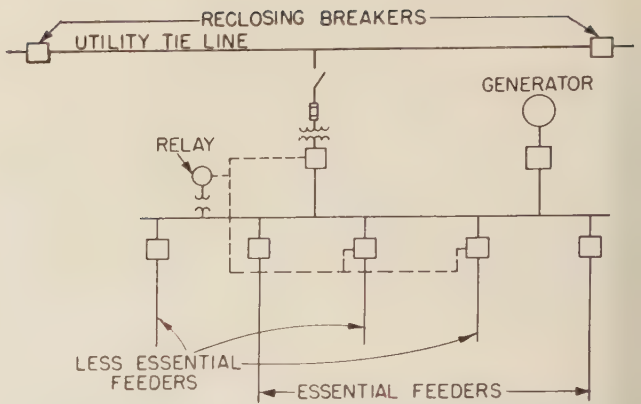

Fig. 1. Industrial plant tapped on utility tie line

there will be no noticeable interruption of power. For only one tie line, Fig. 2, this procedure is only possible if the breakers are very fast on their reclosing cycle (20 cycles or less) and the industrial plant has a large amount of stored energy or generated power compared to the purchased power so that the machines do not pull out of step with the utility in the reclosing period. If the utility system does not use fast reclosing breakers, but uses slow reclosing breakers or manual system of synchronization, procedure (1) is not possible and procedure (3) must be used.

The second procedure in which the less essential load is dropped results in interruption of the nonessential loads. If desired, automatic restarting equipment can be used on the less essential load with the reclosing tie breaker. The motors should not be started simultaneously so a sequencing system must be included.

The third procedure probably requires shutting down more of the plant for a longer time. This procedure must be used for the connections in Fig. 1 since the industrial breaker must open to allow the arc to go out. In both the second and third procedures, relays are required to trip off the less essential loads and open the tie line. Without such relays, the entire plant, including the generating station, would probably go down and the electrically driven auxiliaries would require another source of power until the turbines could be brought back up to speed.

RELAYING METHODS

Since the possibility of the utility breakers reclosing without danger and thus resuming the flow of power is determined largely by the power angle (δ) between the utility voltage and the industrial voltage; i.e., how far the machines are out of step; the relays which can be related to this angle can be used to trip breakers if the power angle becomes too large.

Other types of relays are necessary in the tie to operate in case of faults in the industrial plant or to clear faults in the utility system rapidly. In general, the overcurrent relays or the impedance relays cannot be related to the power angle and will not take care of an interruption of power.

Underfrequency Relay

This relay operates when the frequency is below set value for a given time. Since it must be set as near to the normal frequency as possible to operate fas

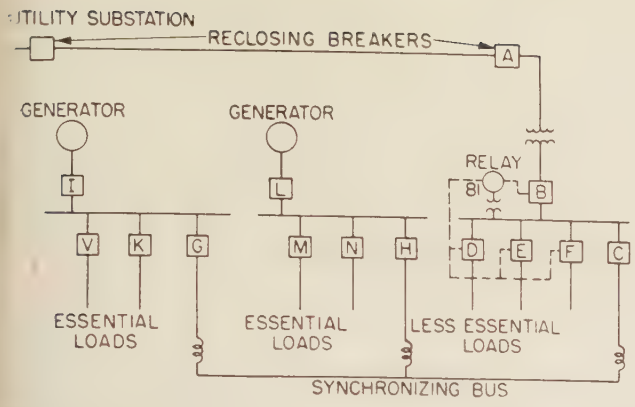

Fig. 2. Industrial plant connected to a single utility substation

...ough in emergencies, it may trip unnecessarily if the ...stem frequency gets too low. Assuming that the ...wer company holds the frequency to 60 ± 0.25 ...cles, the high-speed underfrequency relay can be set ... 59.5 cycles. If the plant load is small when power is ...terrupted, then the deceleration will be small and the ...achines will stay close enough in synchronism so that ...closing would simply pull them up in step. If the ...ad is large, then the machines slow down quickly and ...e relay operates to open the breakers. An example of ...is operation is given in the section on synchronous ...motors.

Reverse Power Relay

This relay operates when the power flow out of the plant exceeds a set value for a given period. The normal interchange of power may require an insensitive setting which would not allow proper operation in an emergency. A study should be made to check whether or not the relay would trip unnecessarily for faults on the utility system.

If the relay can be set so it will trip unless a minimum amount of power is flowing into the plant, then when the utility goes off the relay will sense this immediately and trip the tie breaker.

Inertia Relay

One such relay consists of (1) a small synchronous motor connected to the industrial system so that the motor speed is an indication of the plant frequency, (2) an inertia element or disk so mounted that it can rotate ahead of the motor shaft when the frequency decreases at a high rate, (3) a clutch assembly with a driving arm and adjustable contacts. When the plant frequency is constant or nearly so, the high inertia wheel is driven by the motor. When the frequency drops suddenly, the relay motor slows down while the disk keeps going until the contacts meet.

If the disk is assumed to be in step with the utility and the relay motor in step with the industrial plant, then the angle between the contact on the inertia element and the contact on the motor shaft is the power angle which can be allowed before tripping the breakers.

SYNCHRONOUS MOTORS

For the case where the industrial plant purchases all of its power, the synchronous motors still must be protected against surges of power with automatic reclosing. High-speed underfrequency relays or the inertia relay can be used to open the motor circuits quickly before the power breaker recloses. Then the motors would be restarted manually.

As pointed out by Meyers (*1*) most voltage, current, or frequency relays do not operate fast enough. However, the high-speed frequency relay (G.E. type CFF) has operated successfully when set at 59.5 cycles. It gave the following operating times in one system:

1.	Time from opening tie breaker until frequency falls to 59.5 cycles	4 cycles
2.	Operating time of CFF and auxiliary relays	6 cycles
3.	Operating time of motor breaker	5 to 8 cycles
	Total time	15 to 18 cycles

Actually the total time seemed to be about 17 cycles. The synchronous motors held the voltage up so that the undervoltage devices on the induction motor starters did not drop out minimizing the need for time delay controls. In this case practically all the induction motors rode through the momentary interruptions.

In cases where the manufacturing process cannot stand the short interval required to manually restart the synchronous motors, automatic restarting can be used if the motors have enough torque to resynchronize under load or can be automatically unloaded fast enough.

The underfrequency relay can be used to disconnect the field and leave the stator connected. Then when the power is restored the motor can automatically resynchronize with a slip cycle relay to reconnect the field. However, a synchronous motor with a pull-in torque of 100% or more is needed or automatic unloading equipment to allow the use of a motor with 40 to 60% pull-in torque. Also, since the motors should be started in sequence, the automatic resynchronizing feature may not be economical. The field should be discharged as much as possible which means a large value of discharge resistor (five to ten times the field resistance) and fast operating relays (10 cycles or less).

With two lines from the utility system (Fig. 2) and very fast breakers (3 cycles clearing time) it is possible that the synchronous motors would not pull out of step for even a full three-phase fault. A stability study can be made to determine whether the machines would pull out or not. Here the inertia relay or the fast underfrequency relays should be used also, because if the fault is cleared rapidly before the motor is out of step the relays will not operate and the power is restored with no interruption of production. However,

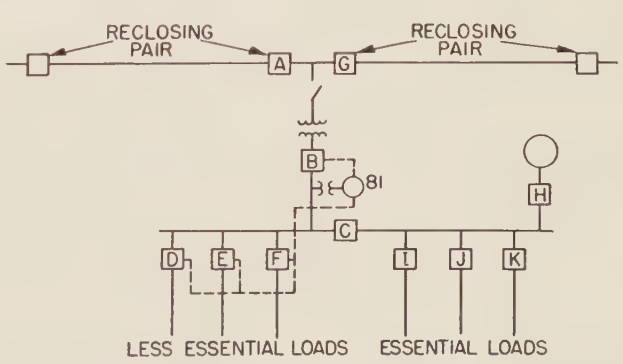

Fig. 3. Industrial plant with two tie lines from the utility system

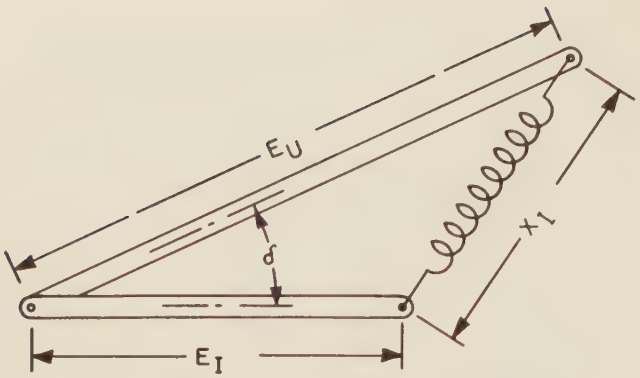

Fig. 4. Mechanical analog of the electrical system

if the fault persists, then the relays take the motors off the line, thus protecting them.

VOLTAGE DIPS

When a fault occurs on a power line there is a momentary dip in voltage before the breakers or fuses clear the fault. Sometimes this voltage dip is low enough and long enough to allow the motor starter contactors to drop out. For essential service motors, such as the powerhouse auxiliaries, time-delay controls should be used to avoid unnecessary shutdown.

SYSTEM CHARACTERISTICS

To help in understanding what can be expected in an emergency, some of the properties of the electrical system are discussed here. The generators and other synchronous machines in the industrial plant operate in synchronism with the utility system; that is, the average speed is the same. When synchronous machinery is interconnected, the amount of power which the utility supplies to the industrial system is determined mainly by the electrical load angle (δ) and the reactance of the tie. Such a system is similar to a mechanical system of two arms having the same pivot with a spring connecting the two as shown in Fig. 4. In order for the arm which is driven to pull the other arm with it, the spring must elongate allowing the arms to separate. The angle δ between the two arms can be called the torque angle, because the torque on the second arm is proportional to the sine of the angle. This angle between the two arms we call the power angle, because when the arms rotate at a constant speed, the power transmitted is a direct function of torque. In the electrical transfer of power the utility voltage (E_U) is analogous to the driven arm and the industrial plant voltage (E_I) to the arm which receives

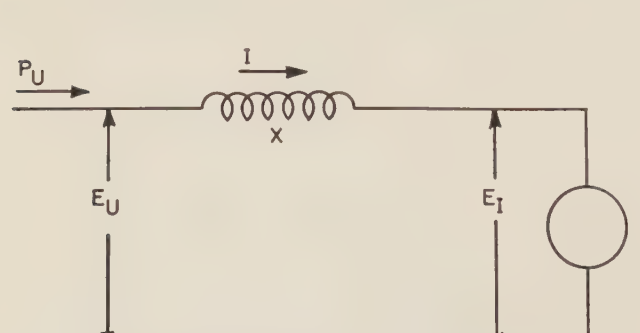

Fig. 5. Simplified system

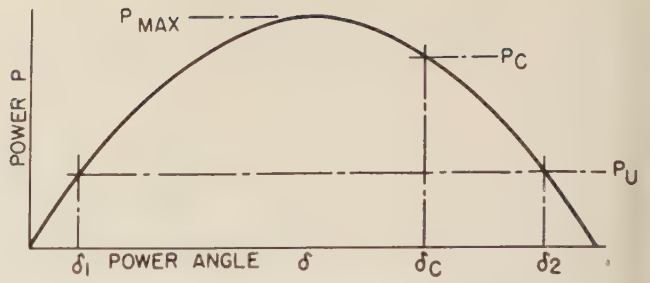

Fig. 6. Power transfer diagram

its torque through the pull of the spring. Thus the systems turn in step (or in synchronism) with the industrial load back at the power angle δ. The voltages on the system, the reactance of the tie connections, the power taken from the utility, and the stored energy in the industrial system all enter in to determine the power angle and the stability of the system. To identify these various quantities, the reactance will be indicated by the symbol X, the amount of power taken from the utility by P_U, and the stored energy in the industrial system by H. Actually, the power systems are generally quite complex, but for the sake of discussion a complex system can be reduced to a single machine with a voltage E_I as shown in Fig. 5.

The amount of power supplied to the synchronous machines depends upon the angle δ between the utility voltage and the generator voltage E_I, as explained by Crary (*2*) or Kimbark (*3*). The mathematical relation is given by equation (1):

$$P = \frac{E_I E_U}{X} \sin \delta \qquad (1)$$

Figure 6 shows a plot of power P versus the angle δ.

For a given power (P_U) being supplied from the utility, the industrial machines run at an average angle of δ_1 degrees behind the utility voltage. When the utility power is interrupted, the industrial system slows down due to the excess load increasing the angle δ and the flywheel effect causes the synchronous motors to act momentarily as generators and supply power to the rest of the plant for a very short time. If the utility power is restored at a later time when the angle between the industrial voltage and the utility voltage is less than δ_C, then the utility supplies a large amount of power which accelerates the industrial machines back

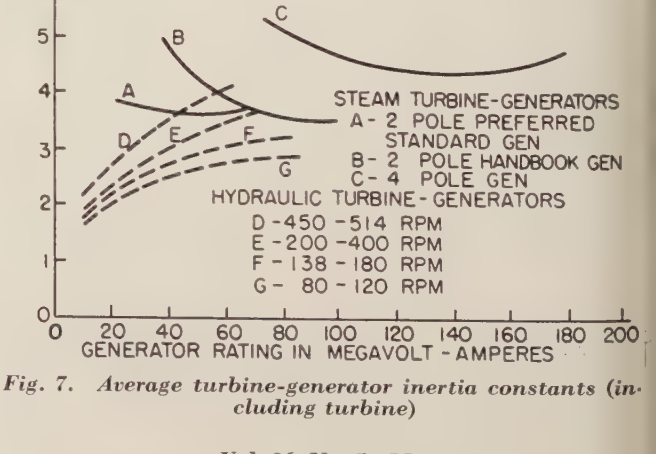

Fig. 7. Average turbine-generator inertia constants (including turbine)

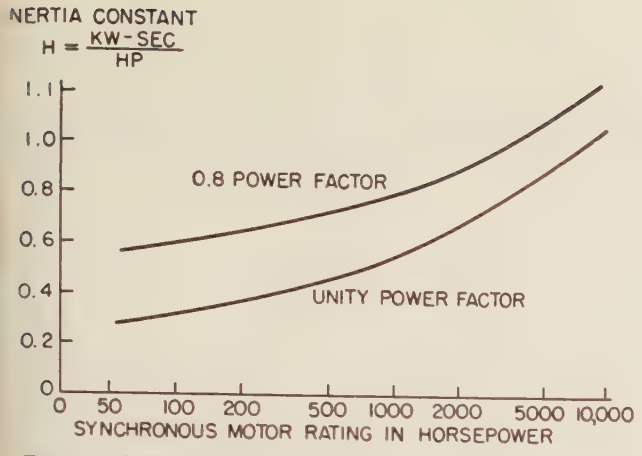

Fig. 8. Average synchronous motor inertia constants

to step. If the generators and motors in the industrial plant are too far out of synchronism with the utility; i.e., δ is greater than δ_C, they will pull completely out of step and cause the large exchanges of power which result in out-of-step operation and may be destructive to the machines.

The angle δ_C is called the critical synchronizing angle, since the system will resynchronize if power is restored when δ is less than δ_C. The value of δ_C is determined by the ratio of power flow at the time of the fault to the maximum power, as shown by equation (2):

$$\cos \delta_C = (\pi - 2\delta_1) \sin \delta_1 - \cos \delta_1 \qquad (2)$$

where δ_1 is in radians.

The switching period (t_s) or time available before the power angle reaches δ_C is given by equation (3):

$$t_s^2 = \frac{2(\delta_C - \delta_1)H}{\pi f P_U} \qquad (3)$$

where the angles are in radians and f is the frequency in cycles per second.

Equations (2) and (3) are based on the simplified network shown in Fig. 5 and the assumption that the utility power is interrupted without an actual fault period.

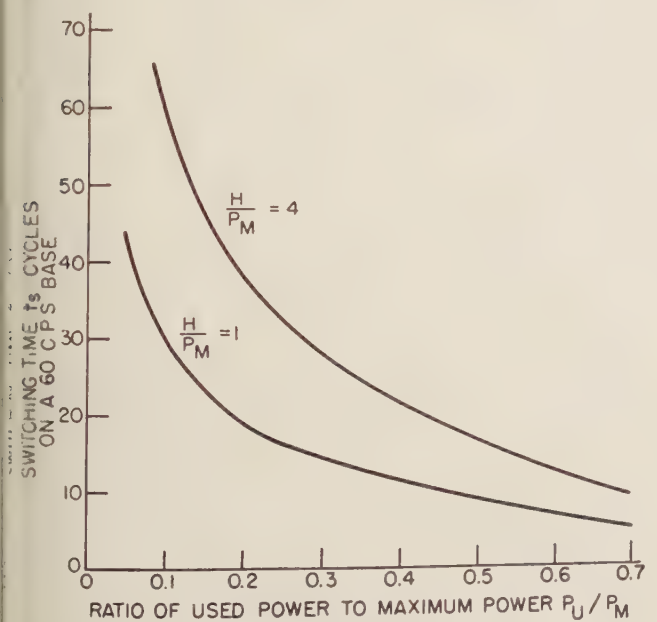

Fig. 9. Available time for reclosing

The stored energy for a machine is given by equation (4):

$$KE = 0.231 WK^2 N^2 \times 10^6 \text{ kw.-sec.} \qquad (4)$$

where WK^2 is the inertia of the machine rotor and load in pound-feet squared and N is the speed in revolutions per minute.

Figures 7 and 8 show typical values of H for various synchronous machines.

The stored energy in induction motors and loads is usually neglected. If the inertia is large enough, the induction machine may act as a generator and help maintain the load, but the reactive kva. to excite it must come from the synchronous machines or from capacitors.

CONCLUSIONS

The utility can reclose breakers after an interruption of power without causing any trouble if the synchronous machines in the industrial plant stay nearly in step; i.e., the power angle is less than the critical value at the time of reclosing. Whenever the power from the utility is totally interrupted, the load in the plant should be reduced to the level which the generators can carry. If there are no generators, the synchronous motors should be disconnected completely or the field excitation removed and the fields connected to discharge resistors before the power is restored.

Two ratios determine the time available for reclosing: (1) the ratio of power being used, P_U, to the maximum which can be transmitted, P_M; and (2) the ratio of the stored energy H to P_M.

Figure 9 shows the switching time available for various ratios.

Conclusions which can be drawn from this figure are:

1. Where the slow reclosing equipment is used with a single tie line, the industrial plant should always be disconnected so the reclosing breakers do not close the tie. Resynchronization can be done manually or automatically, the nonessential loads to be restarted after the plant is in synchronism again.
2. Where fast reclosing equipment is used with a single tie line, the plant loads can be studied to determine the possibilities of reclosing.
3. Where two tie lines are connecting the plant to the utility, then reclosing on each line will always be successful, but if both lines are out at the same time, the industrial plant should be disconnected and resynchronized manually.

LITERATURE CITED

1. Meyers, A. J., "Frequency Relays Disconnect Synchronous Motors Under High Speed Reclosure." *Power Generation*, July, 1949, p. 82, Chicago, Ill.
2. Crary, S. B., Power System Stability. Volume I, "Steady State Stability," 1945, and Volume II, "Transient Stability," 1947, John Wiley & Sons, New York.
3. Kimbark, E. W., Power System Stability. Volume I, "Elements of Stability Calculations," 1948, and Volume II, "Power Circuit Breakers and Protective Relays," 1950, John Wiley & Sons, New York.
4. Newman, L. E., Modern Turbines, 1944, John Wiley & Sons, New York.
5. Project Committee of AIEE Relay Committee. "Relaying of Interconnections Between Industrial and Utility Generating Stations."
6. AIEE 52-6. Report of Joint AIEE-EEI Subject Committee on Line Outages, Nov., 1951.

Received Jan. 13, 1953. Presented at the Seventh Engineering Conference of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Oct. 13–16, 1953.

Polarographic Determination of Reducible Sulphur in Paper

LOUIS GORDON, R. L. EICHENLAUB, and C. P. DONOFRIO

A method is described for the polarographic determination of "reducible sulphur" in paper. Hydrogen sulphide gas generated in the manner described in TAPPI method T 406 m-46 from known sulphur compounds and from paper specimens was delivered to the electrolytic cell of the polarograph. One-tenth normal solution of sodium hydroxide was employed as the supporting electrolyte in the cell. The sulphide ion concentration was measured from polarograms obtained from the resulting solutions. The solutions prepared from known sulphur compounds were utilized for standardization purposes. The polarographic measurements were compared with the "spot tests" produced by TAPPI method T 406 m-46 from the same paper specimens.

THE pulp and paper industry has expressed much interest in a sensitive method for the determination of "reducible sulphur" in paper; the presence of sulphur compounds is believed to be accountable for the tarnishing action of some papers or tissues when used in contact with silver. In this connection TAPPI method T 406 m-46 has come into wide acceptance despite the objections raised with respect to the interpretation of test results. Some of the limitations of this method are set forth in the text of the procedure

In a search for a more satisfactory method for the determination of "reducible sulphur" in paper it became obvious that a more sensitive and accurate method for the quantitative measurement of sulphide ion concentration was of prime importance. To achieve this objective the polarographic technique was investigated. Sulphide sulphur can be determined polarographically (*1*), the height of the voltage-current wave obtained being proportional to the concentration of sulphide ion in solution. The method is well adapted to sulphide solutions of the order of 2×10^{-5} M to $10^{-4}M$.

APPARATUS AND MATERIALS

Polarograph. A Heyrovsky polarograph, Model XII, manufactured by E.A. Sargent & Co., was used for the polarographic measurements of sulphide ion concentration. The instrument may be represented by the conventional circuit shown in Fig. 1.

In all investigations conducted on sulphide solutions the cell was connected so that the dropping mercury electrode was used as the anode and the saturated calomel electrode as the cathode. The reactions at the anode and cathode would be respectively (1) and (2) below.

$$Hg + S^{--} = HgS + 2e^- \qquad (1)$$

$$2e^- + Hg_2Cl_2 = 2Hg + 2Cl^- \qquad (2)$$

The instrument produced a two-dimensional voltage-current curve (Fig. 2) which is analogous to a potentiometric curve.

Electrolytic Cell. Instead of the mercury pool which is frequently used for most polarographic determinations, a saturated calomel electrode was used to complete the cell. As illustrated in Fig. 3 the calomel electrode is connected to an H-type cell by an agar bridge.

Gas Generating Flask. Hydrogen sulphide was generated in a flask especially constructed for this purpose. The flask was supplied by Oneida Ltd., Sherrill, N. Y. (Fig. 4).

Reagents. The reagents used for generating the hydrogen sulphide gas are the same as those specified in TAPPI Standard T 406 m-46.

PROCEDURE

Transfer the test specimen which shall consist of 5.0 grams of air-dry paper accurately weighed and cut into 6 mm. (app.) squares to a beaker containing 50 ml. of distilled water and macerate the paper with a clean glass stirring rod until it is well softened. Using an additional 100-ml. portion of distilled water wash all of the pulp into the special generating flask. Add 2 grams of aluminum foil to the generating flask.

Place the rubber stopper holding the gas trap and nitrogen delivery tube in the neck of the flask.

Before connecting the trap to the electrolytic cell transfer to the cell 30 ml. of 0.1N NaOH solution measured from a buret. After connecting trap and cell, lower the dropping-mercury electrode into place but do not allow mercury to flow until ready to start the polargram.

With all connections secure, heat the solution in the flask to 70°C. and then add 20 ml. of concentrated

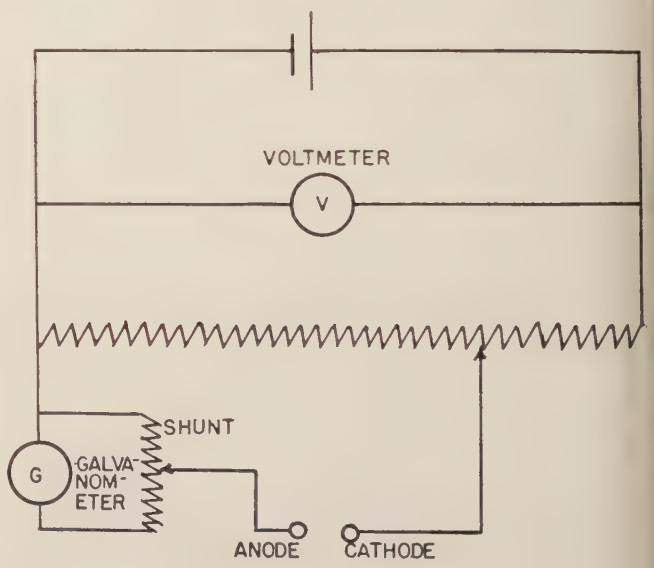

Fig. 1. Conventional schematic diagram of a polarograph

LOUIS GORDON, Associate Professor, Department of Chemistry, Syracuse University, Syracuse, N. Y. R. L. EICHENLAUB, formerly Graduate Student, Department of Chemistry, Syracuse University, Syracuse, N. Y.; present address: Lever Bros., Cambridge, Mass. C. P. DONOFRIO, Associate Professor of Pulp and Paper Manufacture, College of Forestry, State University of New York, Syracuse, N. Y.

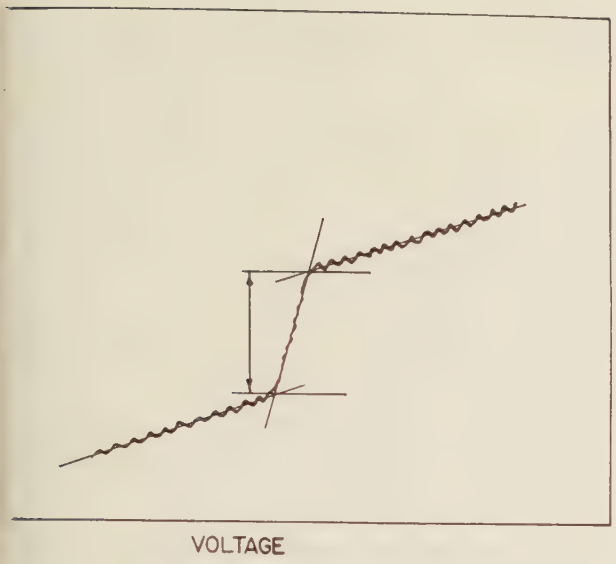

Fig. 2. A typical polarogram

osphoric acid by means of the buret on the side of the k at the rate of 4 ml. per minute. Maintain the mperature of the solution between 70 to 80°C. during addition of acid. Upon completing the addition of d raise the temperature slowly (judge by gas bubbles ssing up through the cell) to 99 to 100°C. Maintain is temperature for 45 min.

After 45 min. at 99 to 100°C. discontinue heating and ubble nitrogen through the flask for 15 min. to sweep ut any hydrogen sulphide which may remain behind and o sweep out any oxygen in the cell. It is very impor- ant that all oxygen be removed from the cell, otherwise well-defined curve will not be obtained.

Take a polarogram of the sulphide solution after the itrogen gas has been bubbled through the cell. To revent the solution in the cell from being drawn back nto the generating flask when the flow of nitrogen is topped, place a pinch clamp on the rubber connection etween the flask outlet and the inlet to the electrolytic ell.

Construct a standard curve relating wave height and er cent sulphur by using known amounts of the tandard sodium thiosulphate solution in place of the aper specimen.

Measure the height of the wave as shown in Fig. 2 or y any of the usual methods.

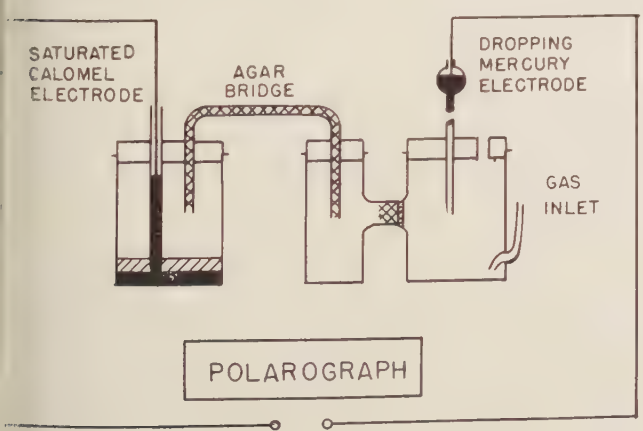

Fig. 3. Electrolytic cell

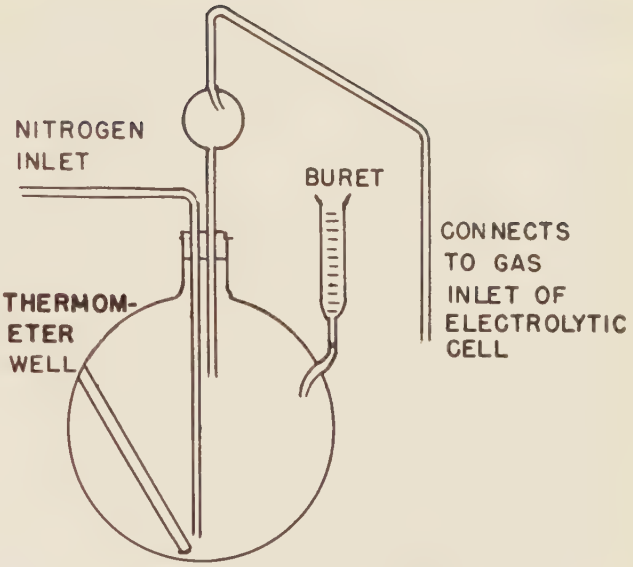

Fig. 4. Gas generating flask

EXPERIMENTAL RESULTS

The polarographic measurements conducted on sulphide solutions prepared from standard thiosulphate solutions are listed in Table I and shown graphically in Fig. 5. The data given as "per cent sulphur" were obtained by utilizing quantities of sodium thiosulphate corresponding to the sulphur content of 5.0-gram samples of air-dried paper.

Reducible sulphur determinations were carried out polarographically on paper samples furnished by Oneida Ltd., Sherill, N. Y. Similar samples were evaluated for reducible sulphur by TAPPI method T 406 m-46. Three different observers were asked to evaluate the results of tests made by T 406 m-46. Table II compares their results with those obtained polarographically. Both samples were run in triplicate by both methods.

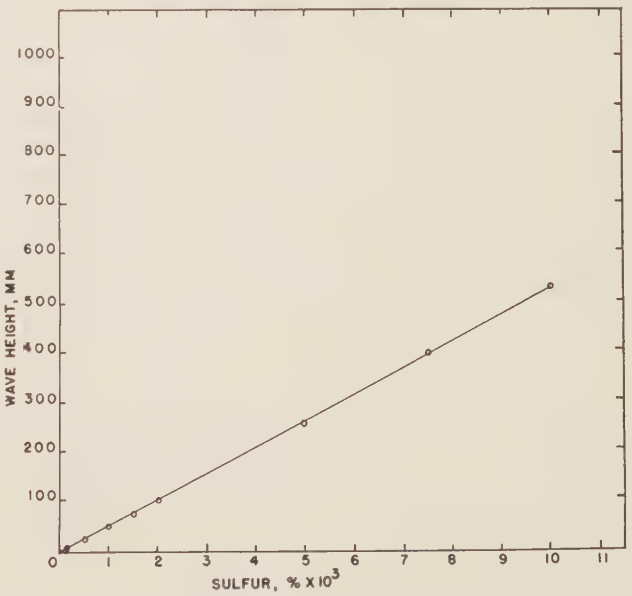

Fig. 5. Standardization relationship between wave height and per cent sulphur based on a 5.0-gram sample of air-dried paper

Table I. Polarographic Determination of Sulphide from Thiosulphate Solution

Sulphur content, %	*Sensitivity*	*Wave height based on sensitivity of 2 mm.*
0.0150	20	740
0.0100	20	530
0.0075	20	400
0.0050	20	260
0.0020	10	100
0.0015	10	75
0.0010	5	50
0.0005	5	25
0.0002	1	10
0.0001	1	5

At approximately $E_{1/2}$, the value of $m^{2/3}t^{1/6}$ is 1.73 mg.$^{2/3}$ sec.$^{-1/2}$. Temperature: 25°C. Drop time: 4.5 sec. Nitrogen added: 15 min. Time to add acid: 5 min. Time at 100°C.: 45 min. H_3PO_4 (conc.) added: 20 ml.

CONCLUSIONS

Any sulphur which can be reduced to the sulphide state and generated as hydrogen sulphide can be determined polarographically.

The polarographic determination of sulphide sulphur can be used to determine sulphide ion quantitatively down to $5\times10^{-6}M$. However, below a concentration of $10^{-5}M$ the step height of the wave obtained, even at favorable sensitivity, is of the order of only 1 cm. A

Table II. Comparison of Results Obtained by TAPPI an Polarographic Methods

Sample No.	*Run No.*	*Reducible sulphur by TAPPI method — Observer A, %*	*Observer B, %*	*Observer C, %*	*Polarographic, %*
1	a	0.0001[a]	0.0001[a]	0.0001[a]	0.00020
	b	0.0001	0.0001	0.0001	0.00018
	c	0.0002	0.0002	0.0001	0.00020
2	a	0.0001	0.0002	0.0002[a]	0.00015
	b	0.0003	0.0003	0.0002	0.00018
	c	0.0002	0.0002	0.0003	0.00018

[a] Less than.

though the error may be slight, the method is bes adapted to sulphide solutions down to $2\times10^{-5}M$.

LITERATURE CITED

1. Kolthoff, I. M., and Miller, C. S., *J. Am. Chem. Soc.* 63: 140 (1941).

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The authors wish to acknowledge the advice and assistance of Dan Gra and James Cox of the Works Laboratory of Oneida, Ltd. of Sherrill, N. Y.

A Method for Quantitative Determination of Wet Bleed

C. CHARLES PEARL and G. J. CARBONE, JR.

A practical wet bleed test for colored paper and a method for obtaining a numerical value for the amount of bleed are presented. This bleed characteristic is measured by the use of a photoelectric colorimeter. The method is simple, and can be rapidly performed and interpreted by nontechnical personnel.

Wet bleed or transfer is a critical factor in the use of colored paper for packaging. The occurrence of bleed is determined by various methods, and the degree of seriousness is judged by visual observation and comparison with a standard. The results are dependent upon the manner in which the bleed test is made, on the eyes and objectivity of the observer, and the surrounding illumination.

It is the purpose of this paper to describe a simple wet bleed test which corresponds well with what happens when a bag made of colored paper becomes wet in use. Further, a method is given for judging objectively the results of the bleed tests, and obtaining a numerical value to represent these results. The method is independent of the source of illumination, and the results lend themselves to use on a control chart.

EXPERIMENTAL

To make the bleed test, two 6 by 12-in sheets of 50-lb. (24 × 36—500) M.F. bleached kraft of about 80% brightness (Photovolt) are held on a clipboard. (This paper was supplied by St. Regis Paper Corp.) A 2 by 3-in. sample of the colored stock to be tested is dipped into distilled water just long enough to wet its surface. This sample is placed felt side down between the sheets of bleached kraft. The upper surface of the top sheet is wet with distilled water to keep it from curling awa from the sample. The sandwich is smoothed by han to insure positive contact between the sample and th white sheets, then it is allowed to dry at 73°F. 50° R.H

This procedure simulates what happens when a article, say a white shirt, is packed in a colored kra bag which gets wet while in use. There is the sam positive contact, and slow drying at normal temper ture.

To judge the amount of bleed, and make comparison with standards, a model 610 Photovolt colorimeter wit a tristimulus scanning head is used. This instrumen has been chosen because of its relatively low cost an the simplicity of operation which allows rapid reading to be taken. Maximum contrast is obtained by usin the amber tristimulus filter for paper in the blue rang and the blue glass filter for colors in the red and gree range.

To give a numerical value to the amount of bleed, photovolt reading is taken on the lower white sheet the sandwich, close to the area touching the sample. second reading is taken on the area which was next t the felt side of the sample. Dividing this second valu by the first, and multiplying the quotient by 100 give the bleed characteristic for that sample.

CONCLUSION

Kraft sheets of 21 different colors were examined b this method. Some of the readings obtained are show in Table I. In a total of 103 samples of all colors, ther was no instance of an anomalous bleed characteristi Using this figure it was possible to set up a table of de scending bleed resistance within a particular col range, and over all the colors.

C. Charles Pearl, Technical Director and G. J. Carbone, Jr., Chief Chemist, Equitable Paper Bag Co., Inc., New York, N. Y.

Table I. Colorimeter Readings on Samples Examined for Wet Bleed

Color	Sample No.	Reading on white sheet (A)	Reading on contact area (B)	Bleed characteristic (B/A × 100)
Blue 5	1	77.0	74.0	96.1
	2	77.0	74.5	96.8
	3	77.0	74.5	96.8
	4	77.0	74.0	96.1
	5	77.0	75.0	97.4
	6	77.5	75.5	97.4
	7	74.0	77.0	96.1
	8	77.0	75.0	97.4
	9	77.0	74.0	96.1
	10	77.0	73.5	95.5
Blue 8	1	78.0	70.5	90.3
Blue 9	1	78.0	48.5	62.2
Green 1	1	72.0	71.5	99.3
	2	72.0	71.5	99.3
	3	72.0	71.0	98.6
	4	72.5	71.5	98.6
	5	72.0	71.5	99.3
Green 6	1	71.5	69.0	96.5
	2	72.0	69.0	95.8
	3	72.0	68.0	94.4
	4	72.0	68.0	94.4
Red 1	1	70.0	68.0	97.1
	2	70.0	68.0	97.1
Red 4	1	71.0	62.0	87.3
	2	71.0	63.0	88.7
	3	70.0	59.5	85.0
	4	70.0	60.0	85.7
	5	70.0	60.0	85.7
Red 6	1	70.0	43.0	61.4

As a result of this work it is thought that this method has the following advantages:

1. Degree of seriousness of color bleed can be determined objectively under any illumination by an untrained eye.
2. Once determined, the bleed characteristic is permanent. There is no need to protect samples against fading, or worry about the effect of age on color.
3. It is possible to evaluate samples which have very similar bleed resistance, where even a trained observer may be left in doubt.
4. The bleed characteristic lends itself to uses in statistical control, particularly by the control chart method, during production of colored paper.
5. The bleed characteristic can be used as a specification when purchasing or accepting an order for colored stock.

Further applications of the bleed characteristic which suggest themselves are the quantitative determination of the amount of wet bleed of colored board, printing inks, and dyed fabrics. Dry and wet crocking may also be measured by an adaptation of this method to these specific properties. There is definite need for an objective, permanent, and quantitative expression of the amount of bleed, and it is hoped that this method will be found to be useful, as well as a stimulus to further work on this problem.

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The Separation of Solids in Deinking Waste by Coagulation and Filtration

JAMES O. THOMPSON, JOHN W. SWANSON, and GEORGE R. SEARS

Laboratory experiments directed toward the elucidation of the principal variables influencing the coagulation and filtration of the solids in deinking waste are described. The reduction of the solids content by simple settling or by lime coagulation followed by settling is of practical interest, and laboratory data obtained by these methods with a series of representative effluent samples are presented. Lime coagulation in general was more effective than was simple settling, though in some cases the advantage was slight. The variability of the effluent from day to day with respect to settling and coagulation was pronounced.

The fibers from magazines and other printed papers are currently recovered by deinking processes (*1*) for reuse as a part of the fiber furnish for the manufacture of certain grades of paper. In addition to the ink pigment on the surface of the printed paper one or more other pigments, e.g., clay, calcium carbonate, satin white, and calcium sulphate, are present either in the coating on the surface of the paper or as a filler distributed throughout the sheet, or both. In current deinking practice the waste paper is disintegrated and cooked with alkali (*2*), dispersing agents, and various other materials with the purpose of dispersing the printing ink pigment so that it can be separated from the stock by washing. In thus cooking and washing the stock, the fillers and coating pigments are also dispersed and separated from the fibers along with the fine fibers and fiber fragments not retained by the filter mat on the washers. The effluent from the washers contains the dispersed ink, the filler and coating pigments, and the fiber fines. A serious stream pollution problem may result if this effluent is discharged directly into a stream or lake, and it is highly desirable to be able to reduce the solids content of the effluent to safe limits before it is discharged (*3*).

One method which may be used in certain cases for achieving this objective consists in removing the insoluble solids from the body of the waste by simple settling, or by chemical coagulation and settling, to form a sludge and then separating this sludge by filtration or other means (*4*, *5*). The daily volume of mill effluent which must be treated is, in general, so large that the selection of a satisfactory coagulating chemical will be severely restricted by economic considerations. The present paper describes a laboratory study of some of the variables which influence this coagulation and filtra-

J. O. Thompson, Research Associate; J. W. Swanson, Research Associate; and G. R. Sears, Research Associate, The Institute of Paper Chemistry, Appleton, Wis.

tion and which are important in the development of a practical and economical method for solids separation.

THEORETICAL CONSIDERATIONS

The composition of the waste from a deinking plant is complex and variable. Among the chief constituents are clay, calcium carbonate, printing ink pigments, cellulose fiber, starch, casein, phosphates, sodium hydroxide, alum, ink vehicle, sodium rosinate, etc., and the pH of the system is of the order of 11. The colloidal nature of the particular system determines the settling and coagulating properties of the suspended solids. The amount of these present in the effluent will vary with the particular system but in general may be expected to range from about 20 to 150 lb. per 1000 gal.

The suspended solids in a given effluent sample may be classified into two groups according to whether they settle or remain suspended under the influence of the earth's gravitational field. The settling of a colloid particle under the influence of gravity is opposed by diffusion resulting from Brownian movement, and it follows that the larger the particle the faster it will settle—all other factors being equal. Some of the particles, however, are so small that they do not sediment at an appreciable rate under the influence of gravity; the problem then becomes either one of increasing the particle size (coagulation) or of increasing the sedimenting force (for example, by means of a centrifuge). The present study is confined to factors influencing coagulation. A number of excellent discussions of the fundamentals involved are available (*6–8*) and hence only a brief outline will be presented here.

Colloidal sols or dispersions are characterized by a very large ratio of surface area to volume of the dispersed phase and accordingly the stability of such a sol is determined largely by surface phenomena. The two factors which appear to be of greatest importance in considering sol stability are (1) the electrical charge carried by the dispersed particle (zeta potential), and (2) solvation. The electrical charge is regarded as resulting either from the sorption of ions on the surface of the colloid particles or from ionization of certain chemical groups on the particle, and may be positive or negative depending upon the particular system. The charge contributes to stability by keeping the particles apart (electrostatic repulsion) and thus prevents coagulation. The sorption of solvent (solvation) to form a protective layer around the suspended particles also serves to hinder coagulation.

In the case of lyophobic colloids—that is, where there is little attraction between the dispersed phase and the liquid medium as in sols of clay, calcium carbonate, calcium sulphate, etc., in water—coagulation may usually be effected by removing the surface charge (ionic layer). This may be done most simply by the addition of small amounts of a neutral electrolyte which provides ions to neutralize the surface charge. The effective ions of course are those having a charge opposite in sign to that on the colloid particles, and the greater the valence of the coagulating ion, the greater is the coagulating efficiency. It should be noted also that charged colloids as well as ions may be used to coagulate colloids of opposite sign. Of particular interest in this connection is the coagulation of clay suspensions in alkaline media with salts of such metals as calcium and aluminum. The rate of coagulation in such cases is much more rapid than at neutral pH, and the phenomenon is regarded as being due to the formation of colloidal suspensions of the metal hydroxides which have positive charges that neutralize the negative charge of the clay particles.

In the case of lyophilic sols—such as starch, casein, or cellulosic materials in water—there is a layer of solvent in addition to a surface charge contributing to stability, and it is usually necessary to remove both before coagulation occurs. This may be accomplished by the addition of large quantities of electrolytes or nonsolvents—in some cases both are required. Surface-active agents may also be expected to produce coagulation under certain conditions. When a lyophilic colloid, such as starch or protein in water, is added to a lyophobic colloid, such as clay in water, the system may behave as a lyophilic sol. Under such conditions the starch or protein acts as a protective colloid and renders the coagulation of the clay, etc., more difficult.

Two other factors which may be of importance in the coagulation of certain colloid systems are temperature and mechanical agitation.

PRELIMINARY OBSERVATIONS

A series of exploratory experiments was performed on a laboratory scale with plant effluent samples to determine in a semiquantitative manner the relative efficiencies of a variety of coagulating agents. The economic aspect of the problem was not regarded as of paramount importance in these experiments; rather it was felt that by examining a wide range of coagulants—some of which would never be expected to be of practical interest—a better understanding of the colloidal behavior of the system would be obtained. This knowledge would then serve as a basis for practical considerations. The general procedure followed in these preliminary experiments was to treat the waste samples of known solids content with an aqueous solution or suspension of the coagulant, stir for 15 min., and then allow to settle for 1 hr. Total solids determinations on the supernatant and sludge permitted a calculation of the extent of coagulation. Direct measurement of the ease of filtration of the sludge was made by means of a filter leaf (*5*). The results of these experiments are briefly summarized.

The addition of calcium ions in the form of a solution of calcium chloride in water (0.75 gram $CaCl_2$ per liter of waste) coagulated the suspended solids more rapidly than did the chemical equivalent (0.4 gram per liter) of an aqueous suspension of lime (CaO). The sludge obtained with the former, however, filtered somewhat less readily. Increased concentrations of lime improved coagulation somewhat. The efficiency of the lime was reduced when the coagulation temperature was raised from room temperature to the normal temperature of the mill effluent (about 50°C.) probably as a result of the negative solubility coefficient of lime. The flocculating efficiency of calcium ions was greatly enhanced by the passage of carbon dioxide into the alkaline suspension. This enhancement was probably due in part to a reduction in pH and probably also to the formation of colloidal $CaCO_3$. Magnesium chloride was found to be somewhat more effective than

Table I. Reproducibility of Simple Settling and Lime Coagulation Experiments

Experiment	pH of supernatant	Solids in waste, lb./1000 gal. Total	Solids in waste, lb./1000 gal. Insoluble	Insoluble solids in supernatant, lb./1000 gal.	Insoluble solids settled out, %	Soluble solids after settling, lb./1000 gal.	Sludge consistency, %	Filter leaf data: Cake consistency, %	Filter leaf data: Filtration rate, lb./hr./sq. ft.
Simple settling	11.5	96.4	62.2	35.6	42.8	30.7	3.28	21.4	1.10
Simple settling	11.5	96.4	62.3	34.8	44.2	32.4	3.26	19.4	1.15
Simple settling	11.5	96.4	62.3	39.8	36.1	31.6	3.50	17.5	1.34
			Mean	36.7	41.0	31.6	3.35	19.4	1.20
0.4 g. CaO/liter	11.7	96.4	62.3	4.97	92.0	30.7	4.31	29.2	2.30
0.4 g. CaO/liter	11.7	96.4	62.3	7.48	88.0	29.9	4.59	28.4	2.80
0.4 g. CaO/liter	11.7	96.4	62.3	6.65	89.5	30.7	4.53	29.8	2.63
			Mean	6.37	89.8	30.4	4.48	29.1	2.58

the chemical equivalent of calcium chloride, though the sludge from the latter filtered somewhat more readily. Mixtures of calcium and magnesium chlorides were more effective than equivalent amounts of either constituent separately. Aluminum chloride was found to be very effective, as was sulphuric acid when used in an amount sufficient to reduce the pH to 7.

The cationic surfactant Hyamine* when used in a concentration of 0.5 gram per liter of waste produced very good coagulation. Lower concentrations of Hyamine were less effective; and the anionic wetting agent Aquarex D† did not produce any coagulation. This latter result is, of course, an expected one, for the previous experiments had indicated that the colloid particles in the waste were negatively charged and hence would be coagulated only by positively charged ions or colloids.

The starch content of the waste was found to have a marked influence on the coagulating efficiencies of lime and of calcium chloride; the higher the starch content, the poorer the coagulation and the slower the filtration rate. This is in agreement with the view that starch may act as a protective colloid. In this connection it is of interest to note that alcohol—acting as a non-solvent—was found to be an efficient coagulant. Protein content as measured by Kjeldahl nitrogen did not appear to influence coagulation.

The use of lime (CaO) at a concentration of 0.4 gram per liter of waste (3.3 lb. per thousand gal.) appeared to offer a practical alternative to simple settling in the event that the latter did not suffice to reduce the suspended solids to tolerable limits. More precise and detailed experiments were therefore made on a series of representative effluent samples taken over a period of 1 month. These experiments which were confined to a comparative study of simple settling and lime coagulation are described in the following sections.

* Rohm and Haas Co.
† E. I. du Pont de Nemours & Co., Inc.

REPRESENTATIVE DATA FOR SIMPLE SETTLING AND LIME COAGULATION

Coagulation Procedure

A standardized experimental procedure was followed in the simple settling and lime coagulation experiments with the representative effluent samples. The simple settling procedure differed from that of the lime coagulation only in that the addition of lime in the former case was omitted. The procedure was briefly as follows. A 1-liter sample of the waste liquor was heated to 50°C. and a suspension of 0.4 gram of CaO in 30 ml. of distilled water was then added. The mixture was stirred at moderate speed for 2 min. and then slowly for an additional 13 min. after which the floc was allowed to settle for 1 hr. The supernatant was then siphoned off. Solids determinations were made on the original waste sample, the supernatant, the settled sludge, and on a portion of the supernatant from which the insoluble solids had been removed by filtration. The filtration rate of the sludge was determined by means of a filter leaf, and the solids content of the resulting cake was determined by oven drying.

Reproducibility

Reproducibility of experimental results was determined by performing simple settling and lime coagulation experiments in triplicate on different portions of a single waste sample. The data obtained are collected in Table I. The columns of major interest for the present purpose are those for "Insoluble Solids Settled Out, %" and "Filtration Rate." Deviations from the means did not exceed about 10%, and the reproducibility may therefore be regarded as satisfactory. The

Table II. Simple Settling Experiments on Deinking Waste

I Sample	II pH	III Solids in waste, lb./1000 gal. Total	III Solids in waste, lb./1000 gal. Insoluble	III-A "Organic solids," lb./1000 gal.	IV Insoluble solids in supernatant, lb./1000 gal.	V Insoluble solids settled out, %	VI Soluble solids after settling, lb./1000 gal.	VII Sludge consistency, %	VIII Filter leaf data: Cake consistency, %	IX Filter leaf data: Filtration rate, lb./hr./sq. ft.
A	11.6	119.5	81.3	47.3	63.0	22.5	34.8	3.55	21.9	0.97
B	11.6	108.7	66.5	32.4	49.8	25.1	39.8	3.31	19.6	1.20
C	11.65	114.5	77.2	47.3	54.0	30.0	35.7	4.85	...[a]	...[a]
D	11.9	134.5	92.0	57.2	52.6	42.8	44.8	3.84	21.0	1.28
E	11.75	136.0	105.2	62.3	64.0	39.1	34.0	4.17	18.6	1.63
F	11.5	127.0	91.3	49.0	69.7	23.7	34.9	5.10	...[a]	...[a]
G	11.85	157.0	112.0	64.0	72.3	28.2	41.5	4.69	21.4	1.51
H	11.7	106.1	66.3	49.0	42.4	34.5	38.6	3.97	...[a]	...[a]
I	11.7	149.1	113.0	66.5	74.0	34.5	39.0	4.31	20.6	1.26
J	11.85	138.5	101.2	58.0	64.8	36.0	44.0	4.20	21.5	1.41
K	11.55	117.8	84.7	50.6	54.8	24.8	34.9	4.67	...[a]	[a]
L	11.8	138.0	97.0	78.0	59.0	39.2	39.8	3.87	17.2	1.42

[a] Insufficient sludge.

Table III. Lime Flocculation Experiments on Deinking Waste
(3.32 Lb. Lime/1000 Gal. Waste)

I	II		III		IV	V	VI	VII	VIII	IX
	pH		Solids in waste, lb./1000 gal.		Insoluble solids in supernatant, lb./1000 gal.	Insoluble solids settled out, %	Soluble solids after coagulation, lb./1000 gal.	Sludge consistency, %	Filter leaf data	
Sample	Crude waste	After flocculation	Total	Insoluble					Cake consistency, %	Filtration rate, lb./hr./sq. ft
A	11.6	11.62	119.5	81.3	54.8	32.6	34.0	4.73	27.2	1.58
B	11.6	11.35	108.7	66.5	46.5	30.1	35.7	3.97	21.7	1.65
C	11.65	11.70	114.5	77.2	48.1	37.7	36.5	4.88	...[a]	...[a]
D	11.9	11.78	134.5	92.0	2.5	97.3	45.6	5.23	27.2	2.10
E	11.75	11.6	136.0	105.0	31.6	70.0	33.2	5.17	26.8	1.9
F	11.5	11.65	127.0	91.3	35.7	60.8	34.0	6.76	32.8	2.37
G	11.85	11.7	157.0	112.0	49.8	54.5	39.0	5.80	26.0	2.01
H	11.7	11.6	106.1	66.3	24.0	63.9	37.4	4.87	32.7	2.16
I	11.7	10.0	149.2	113.0	7.5	93.2	37.4	6.14	29.7	2.14
J	11.85	11.7	138.5	101.2	2.5	97.5	41.5	5.55	31.0	2.0
K	11.55	11.25	117.8	84.7	8.3	90.2	34.9	6.06	32.9	2.64
L	11.8	11.8	138.0	97.0	6.6	93.2	40.7	5.54	26.8	2.18

[a] Insufficient sludge.

superiority of lime coagulation over simple settling in the case of this particular sample is evident.

Simple Settling and Lime Coagulation

Twelve raw waste samples taken during a period of 1 month were treated by the methods of simple settling and lime coagulation. The data for these two series of experiments are collected in Tables II and III, respectively. It will be noted that there is considerable variation within each series as to the extent to which insoluble solids are removed. It will also be noted that the lime procedure gave better results in all cases than did simple settling. This superiority was scarcely significant in some cases, e.g., samples B and C; in others it was very marked, e.g., samples I, J, K, and L. The variable and complex nature of the waste is clearly indicated by these results.

Table IV. Biological Oxygen Demands[a] of Whole Wastes and Supernatant Liquids

Sample	Whole waste B.O.D., p.p.m.	Supernatant after simple settling		Supernatant after lime coagulation	
		B.O.D., p.p.m.	Percentage reduction	B.O.D., p.p.m.	Percentage reduction
A	1,600 (61,000)[b]	1,360 (51,000)[b]	15	1,280 (48,000)[b]	20
B	1,600 (61,000)	1,200 (45,000)	25	1,080 (41,000)	32
C	1,800 (68,000)	1,360 (51,000)	24	1,280 (48,000)	29
D	1,560 (59,000)	1,060 (40,000)	32	660 (25,000)	58
E	2,240 (85,000)	1,360 (51,000)	39	1,200 (45,000)	46
F	1,800 (68,000)	1,440 (54,000)	20	1,240 (47,000)	31
G	2,320 (88,000)	1,600 (60,000)	31	1,440 (54,000)	38
H	2,200 (83,000)	1,720 (65,000)	22	1,560 (59,000)	29
I	2,720 (103,000)	1,800 (68,000)	34	1,800 (68,000)	34
J	2,040 (77,000)	1,520 (57,000)	25	1,120 (42,000)	45
K	1,680 (64,000)	1,200 (45,000)	29	980 (37,000)	42
L	2,120 (80,000)	1,440 (54,000)	32	1,320 (50,000)	38
Av.	1,973 (75,000)	1,422 (54,000)	27	1,247 (47,000)	37

[a] The B.O.D. values were obtained after a 5-day incubation period at 20°C.

[b] Figures in parentheses are population equivalents figured on total waste of 750,000 gal. per day, density of 8.4 lb. per gal., and oxygen requirement of 0.167 lb. per person per day. B.O.D. in p.p.m. is multiplied by 37.8 to obtain population equivalent.

The "Organic Solids" data of Table II, column III-A, were obtained by calculation from "Total Solids" and ash determinations on the whole waste. These data were desired for two purposes; (1) to determine whether a relationship existed between flocculation behavior and total organic content, and (2) to determine whether marked differences in fiber loss occurred from day to day. It will be noted that the variation was from 30 to 80 lb. per 1000 gal. No simple correlation between organic content and simple settling or lime flocculation behavior is apparent from the data.

A comparison of the filter leaf data for the two series shows that the filtering characteristics of the sludges from the lime experiments were consistently better than those from the corresponding simple settling experiments. Some separate experiments with sludges from simple settling experiments showed that the filtration rate of these sludges could be significantly improved by the direct addition of lime. The improvement was less, however, than could be obtained by the addition of the same amount of lime to the original waste in the standard manner.

Biological Oxygen Demand

In order to determine the influence of simple settling and lime coagulation on biological oxygen demand, measurements were made on the twelve untreated waste samples and on the supernatants obtained by simple settling and by lime coagulation. The data obtained are given in Table IV, where it will be seen that the maximum reduction with simple settling was about 40% and with lime coagulation about 60%.

LITERATURE CITED

1. Nadelmann, Alfred H., *Paper Ind.* 31, 330–333 (1949). See also West, Clarence J., Deinking of Paper, Bibliographic Series, No. 151–153, 2nd ed., 1951, The Institute of Paper Chemistry, Appleton, Wis.
2. Carr, Ralph, *Paper Ind.* 31, 337–338 (1939).
3. Palladino, A. J., *Paper Ind.* 31, 341–342 (1949).
4. Hodge, W. W., and Morgan, P. F., *Sewage Works J.* 19: 830–862 (1947).
5. Morgan, P. F., *Sewage Works J.* 21: 512–521 (1949).
6. Hauser, Ernst A., *J. Phys. & Coll. Chem.* 55: 605 (1951).
7. Weiser, H. B., "Colloid Chemistry," 2nd ed., New York, John Wiley and Sons, Inc., 1949.
8. Alexander, A. E., and Johnson, P., "Colloid Science," New York, Interscience Publishers, 1946.

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Low Molecular Substances of Lignin Origin in Black Liquors from Sulphate and Soda Pulping of Spruce Wood

TERJE ENKVIST and BO ALFREDSSON

With ordinary soda and sulphate digestions of spruce wood lignin about 6% of the wood is degraded into substances which cannot be precipitated by adding mineral acids to the black liquor. This loss of lignin consists of three parts, each comprising about 2% of the wood: (1) the fraction already dissolved from the wood at about 100°C. The methoxyl content is low and the ultraviolet absorption spectrum different from the spectrum of lignin, (2) lignin destroyed to nonaromatic substances, (3) degradation products of lignin obtained mostly at the maximum temperature of the digestion (160 to 180°C.). The main part of this fraction seems to be composed of derivatives of dimers of the phenyl propane units of lignin besides small amounts of vanillic acid and simple methoxy ketones such as acetoguaiacone. Through heating isolated soda or sulphate lignin with sodium hydroxide solution at about 170°C. about 7 to 26% of the lignin can be degraded to a product which is almost identical with part 3 named above. With a two-step sulphate digestion at 100 and 167°C. and a subsequent heating of the obtained sulphate lignins with lye about 35% of the lignin of spruce wood was converted into products soluble in ethyl ether. The mechanism of this reaction is discussed.

E. Hägglund and his collaborators (*1*, *2*) have shown that with soda and sulphate digestions of spruce wood part of the lignin is degraded into substances which cannot be precipitated by adding of mineral acids to the black liquor (*3*, *4*, *5*). This loss of lignin can be roughly estimated from the difference between the amount of the lignin in the wood and the sum of the amounts of lignin remaining in pulp and lignin precipitated on addition of acid to the black liquor. Calculated in this way it is about 6% of the wood with ordinary soda and sulphate cooks at 160°C. (Fig. 1). Figure 2 demonstrates a special kind of soda and sulphate cook made in series at rising temperatures. A certain loss of lignin seems to occur at the beginning of the cook, amounting to about 2% of the wood. At 130°C. there seems to be an interval where only a slight increase in the loss of lignin occurs, but at 160°C. the degradation is resumed. The curves showing the losses of lignin are very similar for both soda and sulphate cooks. In contrast, lignin which can be precipitated by acids is formed considerably more in sulphate than in soda digestions, especially at low temperature ranges (100 to 130°C.).

In order to estimate the amount of lignin degradation products the ultraviolet absorption spectra were measured for the acid filtrates obtained after removing the lignin by filtration. The concentration of aromatic lignin degradation products was approximately estimated by comparison with the extinction value ($E^{1\%}_{1cm.}$ = 245) at the peak of the typical lignin absorption maximum at 280 mmu for a phenolic, ether-soluble fraction of a sulphate lignin from the Korsnäs mill. Further, lignin degradation products were isolated from the acidified black liquors by extraction or absorption. The best combination of extraction methods so far developed seems to be extraction by shaking first with ethyl ether and then with sec. butanol, and finally absorption on charcoal and subsequent elution of the coal with sodium hydroxide solution. Figure 3 gives an example of how the absorption spectrum of a black liquor filtrate is changed step by step by such extraction methods (terms E and k in all graphs according to (*13*)). Most of the amounts of ether extracts coincide well as to order of magnitude with the ones calculated in the manner described above from the diminution of extinctions of the water solutions occurring at the extraction with ether. Table I gives examples of spectroscopically calculated amounts of aromatic substances in black liquor filtrates after digestions of various kinds.

The ether extracts from the black liquor filtrates are mostly sticky oils of light brown color. They can be sublimed to a large extent in vacuum and are only partly condensed and determined as lignin with ordinary Klason lignin determinations (*6*). In contrast to resin and fatty acids they are practically insoluble in petrol ether. Substances such as the "native lignin" of F. E. Brauns (*7*) had been removed from the wood before the laboratory pulpings by thorough extraction with acetone (remaining acetone solubles <0.1%).

Part of the ether-soluble substance in black liquors

Table I. Distribution of Lignin Degradation Products in Black Liquors from Soda or Sulphate Digestions on Spruce Wood

King of digestion	*Soda*	*Sulphate*	*Sulphate*	*Sulphate*
Alkali (as NaOH), % of wood	27.5	25.6	19.2	25.5
Sulphidity[a]	0	32.2	32.2	31.2
Time at maximum temperature, hr	3	3	3	5½
Temperature, °C.	160	160	160	140
Per cent of wood:				
Precipitate (lignin) obtained on acidifying	15.9	15.0	13.6	19.6
Ultraviolet light absorbing substance in the filtrate:[b]				
Before extraction with ether	4.1	6.5	5.4	1.8
After extraction with ether	1.3	3.1	2.2	1.0[c]

[a] Per cent Na_2S (as NaOH): % NaOH + % Na_2S (as NaOH).
[b] Values based on the assumption that the extinction of the lignin degradation products are $E_{1\text{-}1\text{ cm.}}^{1\%} = 245$.
[c] The weight of the ether extract was 0.70% of the wood as compared with 0.80% calculated from the extinction data.

Terje Enkvist, now professor of Chemistry at the University of Helsingfors, Finland, and Bo Alfredsson, Swedish Forest Products Laboratory, Department of Wood Chemistry, Stockholm, Sweden.

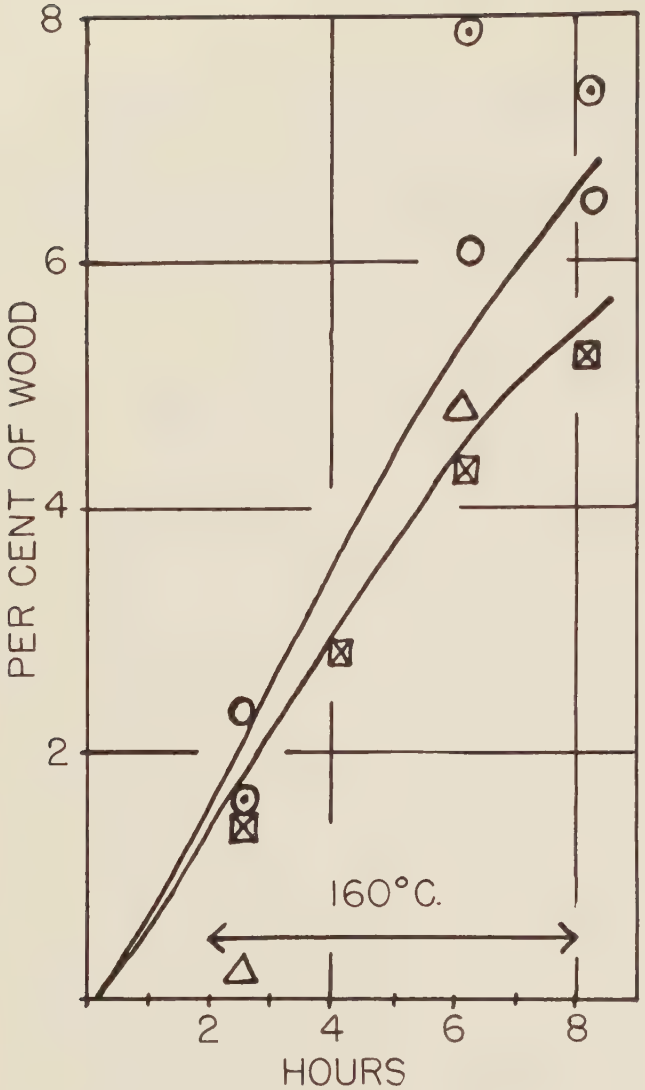


Fig. 1. Loss of lignin at ordinary sulphate and soda digestions

Calculation of lignin remaining in pulp from determinations of: Klason lignin (*6*), ⊙ soda digestion, ⊠ sulphate digestion; % OCH_3, supposing that it is proportional to lignin content, ○ soda digestion, △ sulphate digestion.

dissolves only slightly in water. On the addition of acid to the black liquor and subsequent filtration, part of these substances may pass to the filtrate, but some are precipitated together with the main part of the lignin and can be isolated from the precipitate by extraction with ether, e.g., in a Soxhlet apparatus.

Calculations show that lignin to the amount of about 2 to 3% of the original wood seems to be destroyed to nonaromatic substances during ordinary soda and sulphate pulpings. At 100°C. only a small loss occurs.

Spectra of acidified and filtered black liquors obtained at pulpings at different temperatures are given in Fig. 4. They show that even the black liquors from digestions at 100°C. absorb in the ultraviolet, but that the typical lignin absorption maximum at about 280 mmu is gradually developed only by digestion at higher temperatures.

ANALYSES OF ETHER-SOLUBLE LIGNIN DEGRADATION PRODUCTS

A series of ether extracts from acidified and filtered black liquors was analyzed. The conventional separation of the ether extracts in aldehydic, acidic, phenolic, and neutral fractions (*8*) was used, but it was not very efficient because some of the keto phenols in the ether extracts seem to be so acidic that they dissolve in sodium bicarbonate solution. The separation of carbonic acids and keto phenols was effected in some cases by dissolving the mixture in aqueous alcohol, neutralization with ammonia, and precipitation with ferric chloride solution which precipitated the carbonic acids, but not the keto phenols, as ferric salts. The 2,4-dinitrophenylhydrazones of some of the ketonic fractions could be separated by paper chromatography using 75% methanol and carbon tetrachloride as eluents by which they were usually divided into a yellow and a red fraction. The spectrum of the latter in the case of a

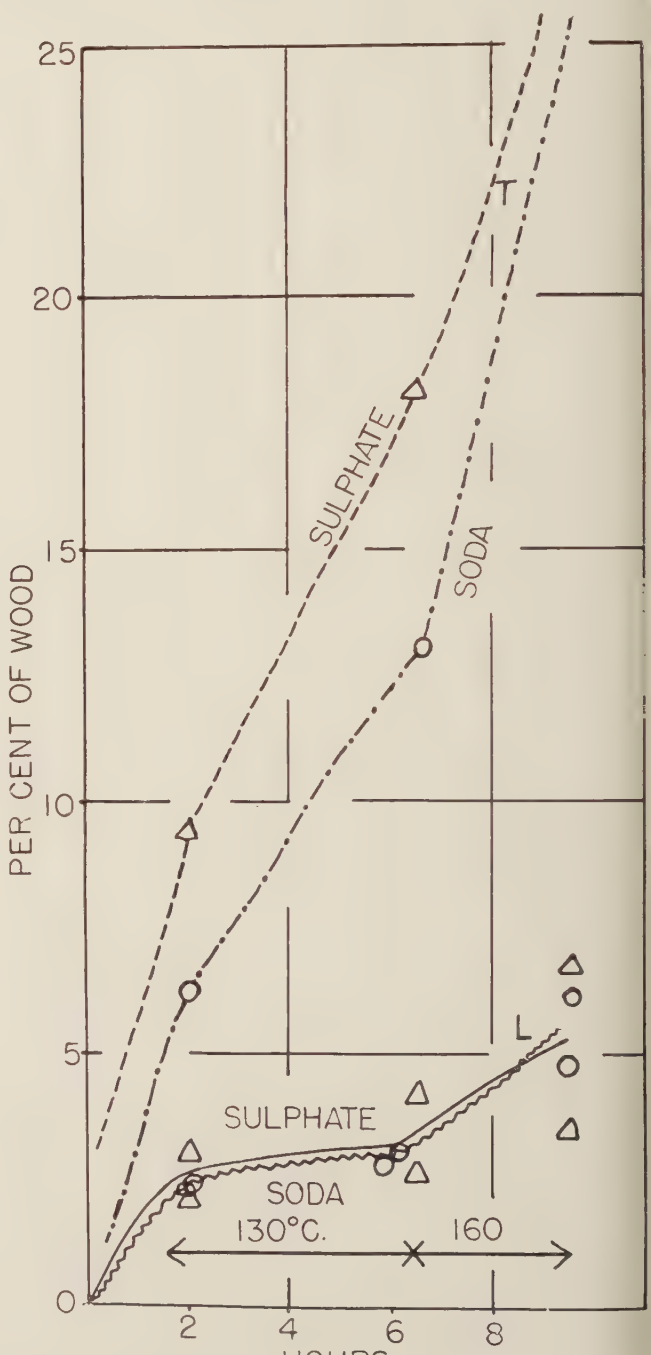


Fig. 2. Dissolution of lignin at special soda and sulphate digestions

△ sulphate, ○ soda.

oda digestion at 160 to 165° (Fig. 5) showed an absorption maximum in the region of about 280 mmu very much resembling the one in the 2,4-dinitrophenylhydrazone of acetoguaiacone; in contrast, the yellow fractions did not show any clear peak of absorption here.

It is impossible to go into detail here about the numerous analyses made. The fractions of the ether extracts contained 6.5 to 15.3% OCH_3. The main portion sublimed in vacuum (about 2 to 10 mm.) at a temperature of about 200 to 275 °C. and therefore seems to contain derivatives of dimers of the phenyl propane unit of lignin. There were also fractions boiling mainly at 140 to 180 °C. at 2 to 10 mm. Three main types of substances could be separated, namely:

1. Carbonic acids, among them vanillic acid, which could be isolated in crystalline state and identified by mixed melting point in yields of about 0.1% of the wood from the black liquors after a soda digestion at 160 to 165° and also after a sulphate digestion, $5^1/_2$ hr. at only 140 °C. In the former case, identification was made also by measuring the ultraviolet absorption spectrum.

2. Aldehydic fraction, which in case of a technical sulphate black liquor from the mill of Husum, contained vanillin, identified by sublimation and mixed melting point determination in a yield of about 0.05% of the wood.

3. Methoxy phenol ketones with spectra very similar to that of acetoguaiacone. In the case of the soda digestion at 160 to 165 °C. the ketone, however, was not identical with acetoguaiacone. It gave a 2,4-dinitrophenylhydrazone, which after three recrystallizations from benzene, methanol, and 80% pyridine, respectively, had m.p. 278 °C. and gave a strong depression of melting point on admixture with acetoguaiacone-2,4-dinitrophenylhydrazone.

Even the ether extracts of precipitated soda and sulphate lignins were analyzed in two cases. The soda digestion was made for 6 hr. at 160 to 165 °C. with alkali (NaOH) in the white liquor to the amount of 25% of the wood. The yield of pulp was 46.9% with 1.27% OCH_3, and the yield of lignin precipitated with hydrochloric acid from the black liquor 22.5% of the wood, containing 15.13% OCH_3. This lignin from the soda digestion contained 4.9%, a sulphate lignin from a technical digestion at Korsnäs mill 7.9% ether solubles (free sulphur was removed through extraction with carbon disulphide). Some of the main fractions showed molecular weights (Rast) of about 300. In case of the soda digestion the main fractions had methoxyl contents of 14 to 16%. Figure 6 gives a typical example

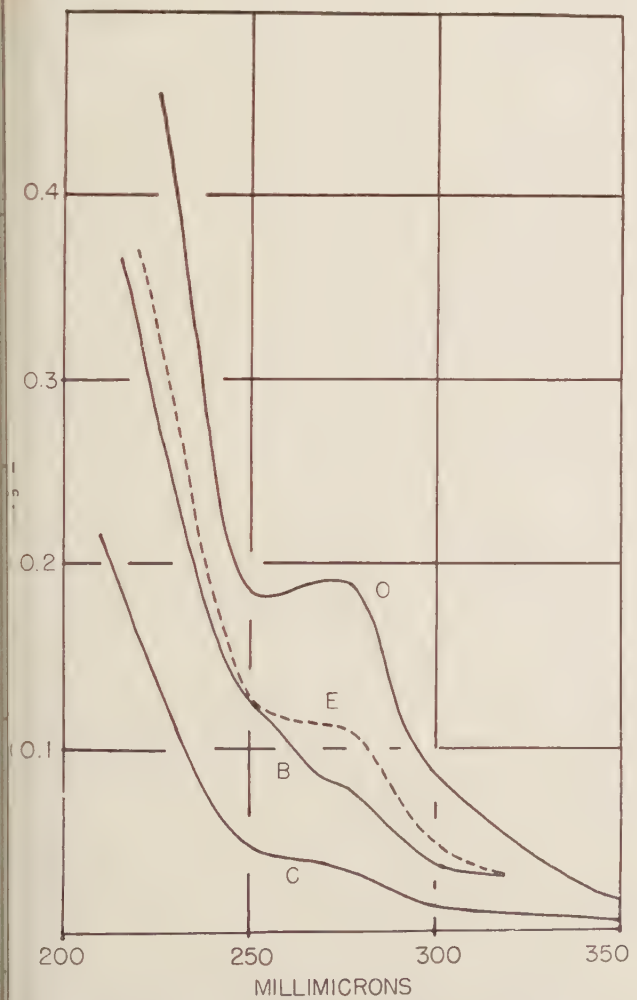


Fig. 3. Spectrum of acidified and filtered black liquors, after sulphate digestion of wood at 140°C.

O = original acid black liquor filtrate. E = after extraction with ether. B = after extraction with sec. butanol. C = after treatment with charcoal.

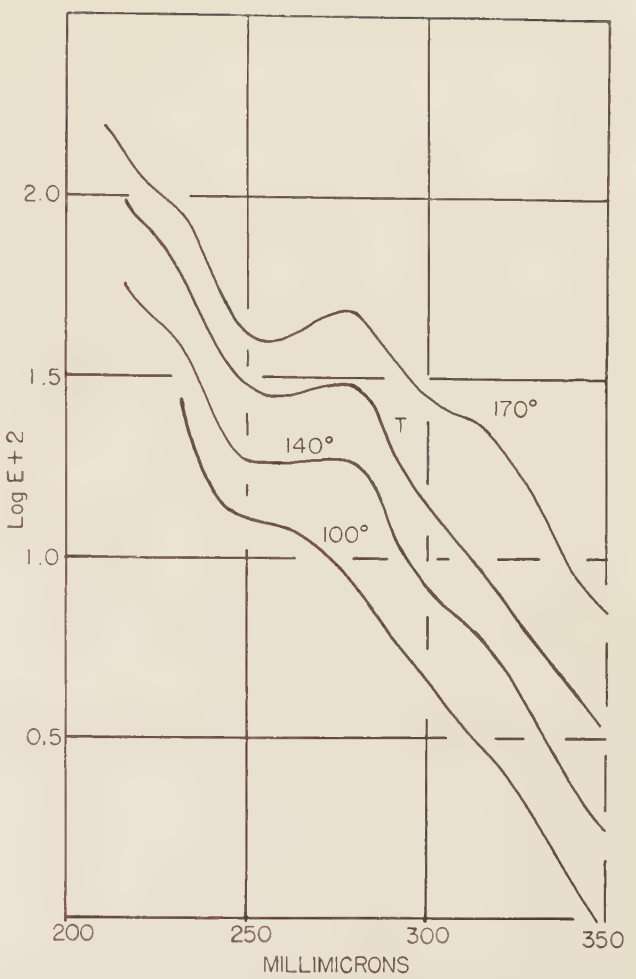


Fig. 4. Spectra of acidified and filtered black liquors from sulphate digestion

100° = sulphate digestion of wood at 100°C. 140° = sulphate digestion of wood at 140°C. T = technical sulphate black liquor from Korsnäs mill. 170° = isolated sulphate lignin digested with 5% NaOH solution.

Fig. 5. Spectra of 2,4-dinitrophenylhydrazones

Solvent: 95% ethanol.
A = derivative of acetoguaiacone. Y = yellow fraction of derivative of phenols from soda digestion at 160 to 165°.
R = red fraction from same. V = derivative of vanillin.

of an absorption spectrum in neutral and alkaline solution for one of these main fractions, namely phenols unprecipitated by lead acetate in alcoholic solution (compare (*9*)), eluted with ether from an alumina column, yield 1.19% of the lignin precipitated from the soda black liquor with hydrochloric acid, 16.34% OCH_3, molecular weight (Rast) 305, equivalent weight ($BaCl_2$-method (*10*)) 318, $E^{1\%}_{1\,cm.} = 334$. There is a strong red shift of the absorption maximum in alkaline solution indicating a high content of phenolic hydroxy groups, probably one in every or every second phenyl propane unit. On the whole, the spectrum indicates a phenolic lignin substance with somewhat fewer or simpler substituents than in ordinary lignin and with a certain but not very high content of carbonyl of the acetoguaiacone type. Most of the other fractions from the ether extracts of the soda and sulphate lignins gave very similar spectra. A comparison of values of extinction and per cent OCH_3 gives no indication of the occurrence of any considerable amounts of demethylated lignin degradation products (pyrocatechol derivatives).

Substances of very different composition were found on investigation of the ether extracts from digestion of wood with sodium hydroxide solution at 100°C. A crystalline, methoxyl-free substance $(C_3H_4O)_n$ was isolated from the phenolic fraction by vacuum sublimation and crystallization. It has a sharp and simple spectrum with a strong red shift and a main maximum acid solution at 260 mmu, thus at a much shorter wavelength than in common lignin preparations. A closer investigation is in progress. The oily part of the sublimate from the phenolic fraction, and also the whole sublimate from the acidic fraction showed low methoxyl contents (2.8 and 4.8% OCH_3, respectively). It can be said that if any true lignin degradation products are already formed at 100°C. they probably originate from some unusual type of fraction or end grouping in the lignin.

DEGRADATION OF ISOLATED ALKALI LIGNINS THROUGH HEATING WITH LYE

The investigation of the lignin degradation products

Table II. Analysis of Ether Extract from Acidified ar Filtered Solution After Digestion of 1 Part of Ether-I soluble Soda Lignin with 20 Parts of 5% NaOH Solutio 4 Hr. at 170°C.

Fraction	*Soda lignin, %*	*OCH_3, %*	*Mo-lecula weigh (Rast*
Aldehydes ($NaHSO_3$-solubles)	0.182	...	...
Acids ($NaHCO_3$-solubles)	1.246	13.61	338
Phenols (NaOH-solubles)	0.889	17.92	157
Neutral substance	0.055	...	...

was made difficult by the presence in black liquors large amounts of substances of carbohydrate origi It was therefore interesting to find that isolated ethe insoluble *soda or sulphate lignins could be in part degrad to ether-soluble products by heating with an excess of abo 6% sodium hydroxide solution at 170°C.* The degrad tion product could be isolated through acidification ar extraction with ether from the acid filtrate and the li nin precipitate. The ultraviolet absorption spectra the aqueous solutions (Fig. 7) are rather sharp, obv ously because the substances are almost free from sul stances of carbohydrate origin.

Studies of the reaction conditions of this alkali hydrolysis of alkali lignin showed that presence sodium hydrosulphide does not have any positiv effect. The reaction proceeds with rather high spee with 20% sodium hydroxide solution, but goes fairl well also with 1% lye or with sodium carbonate sol tion. The best results are obtained through successiv short-time heatings of the alkali lignin with 5% ly with interruptions for the acidifying and removing degradation products. If the heating with the lye continued too long, the reaction goes too far, and considerable loss of aromatic substance occurs. Th degradation seems to stop when about a fourth of t lignin is degraded into ether-soluble products. T ether-insoluble part of common technical sulphate l nin, and also of soda lignin, gives only 7% ether solubl after the first 4 hr. heating with 5% sodium hydroxi at 170°C. Much better results can be obtained b carrying out a sulphate digestion in two steps, at fir at 100°C. and then at 167°C. The ether-soluble ligni

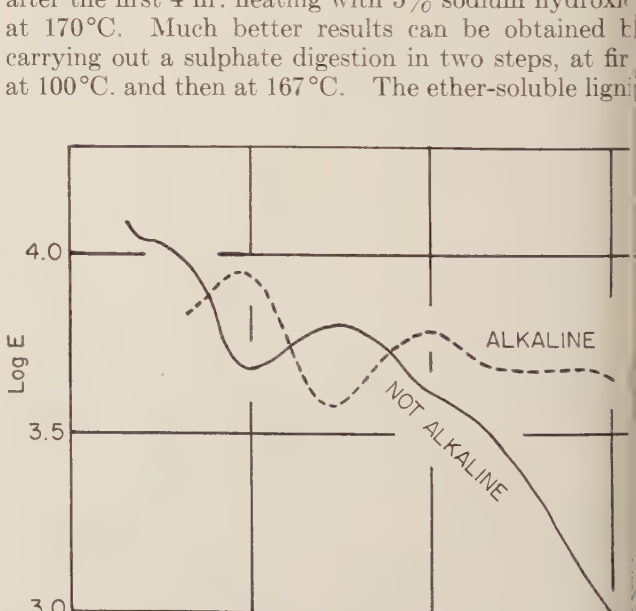
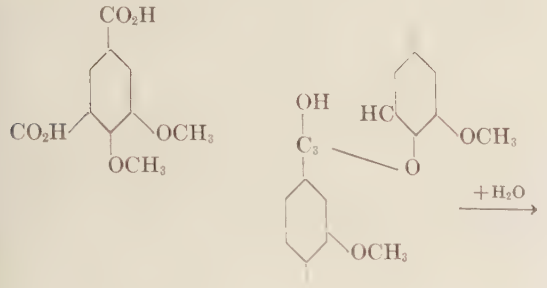


Fig. 6. Soda digestion at 160 to 165°C. Ether eluate fro lignin precipitate, special phenol fraction

Solvent: 95% ethanol.

rom both steps gives about 20% ether solubles after 4 f cooking at 170°C. In the following 4 hr., the yield f new ether solubles is only 6% of the original sulphate gnin. The sum of ether-soluble lignin degradation roducts obtained with this two-step sulphate digestion n the following alkaline hydrolysis of the sulphate gnin is 35% or more than a third of the od.



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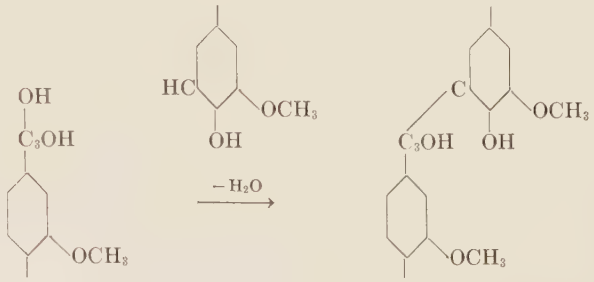
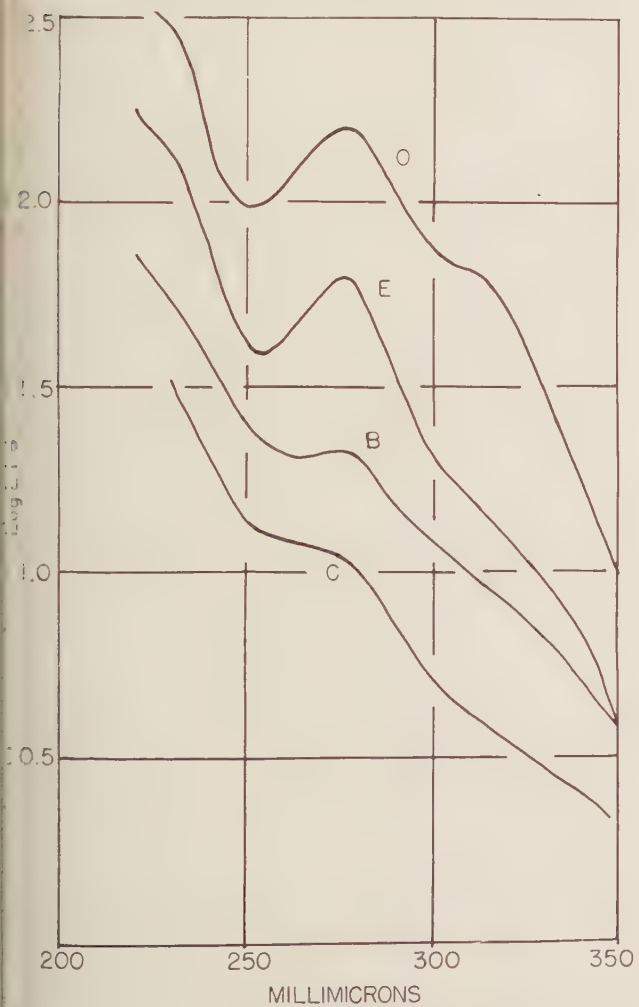


II

n example of the compositions of the ether-soluble radation products of alkali lignin is given in Table II. Through sublimation at about 5 mm. crystalline *illic acid* could be obtained from the acids fraction f crystalline *acetoguaiacone* from the phenols. Both stances were identified by mixed melting point determination and ultraviolet spectrum; the yields were 0.1% of the lignin for each substance. During the sublimation of the phenols a small first run of 0.03% of the lignin was obtained which according to its smell and absorption spectrum (Fig. 8) seems to contain guaiacol.

Acetoguaiacone is thus shown to be a product of sodium hydroxide hydrolysis of soda lignin. Sodium hydrosulphide, therefore, is not necessary for the formation of acetoguaiacone at alkaline digestions (compare (*2*)).



g. 7. Spectrum of acidified and filtered solution after digestion of isolated alkali lignin with NaOH solution

O = original solution. E = after extraction with ether. = after extraction with sec. butanol. C = after treatment th charcoal.

DISCUSSION OF THE MECHANISM OF THE ALKALINE DEGRADATION OF LIGNIN

Perhaps the alkaline hydrolysis of alkali lignin can be provisionally and very crudely explained by the following working hypothesis:

Our earlier work (*11*) has indicated that sulphate and soda lignin from spruce contains one free phenolic hydroxy group to almost every phenyl propane unit. Thus it appears that most of the phenol ether bonds in

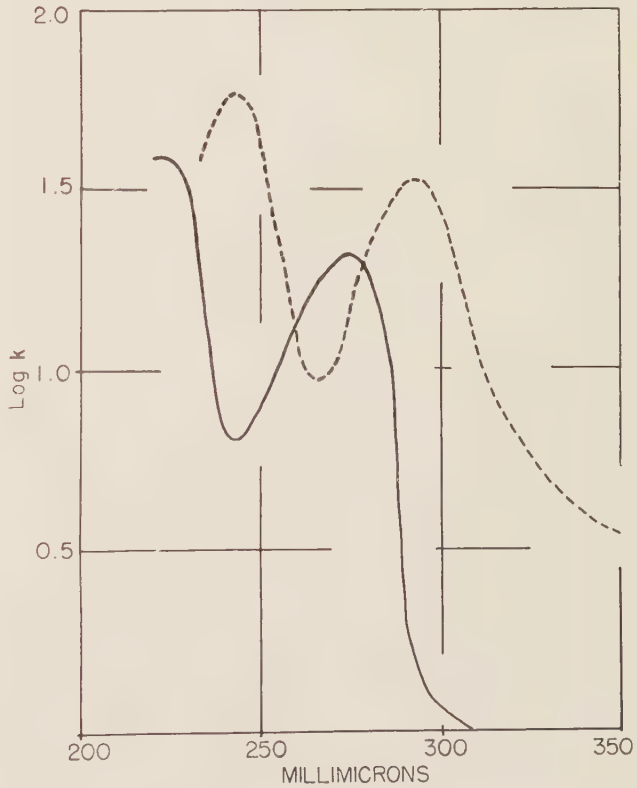


Fig. 8. Digestion of soda lignin with NaOH solution

Guaiacol from the phenolic part. Solvent: 95% ethanol. —— Not alkaline. ----- Alkaline.

wood lignin are opened during the sulphate or soda digestion. This reaction should involve an addition of about one molecule of water to each phenyl propane unit. The carbon, hydrogen, and oxygen contents of alkali lignin, however, are much the same as in lignin preparations, such as hydrochloric acid lignin or cuproxam lignin, which have low phenolic hydroxyl contents. Therefore, there would also seem to occur a splitting off of water in the formation of alkali lignin, compensating for the addition of water to the phenyl ether bonds. The work of Richtzenhain (*12*) shows that the sulphate lignin on methylation and oxidation gives an unusually high yield of isohemipinic acid (I). The simplest way to explain these facts seems to be an assumption that the alkali digestion also involves a formation of carbon bridges between benzene nuclei, in the 5-position, and accompanied by a splitting off of water (II). When alkali lignin is slowly degraded into such products as acetoguaiacone and vanillic acid besides substances with higher molecular weights, this process presumably involves a breaking up of carbon bridges between two benzene nuclei. This process seems to be in some respects analogous to the formatic of vanillin and acetoguaiacone from lignosulphonic ac by heating with sodium hydroxide solution.

LITERATURE CITED

1. Hägglund, E., *Cellulosechem.* 5: 81 (1924).
2. Enkvist, T., Moilanen, M., and Alfredsson, B., *Svensk Pa perstidn.* 52: 53 (1949) (in German).
3. Metha, M., *Biochem. J.* 19: 958 (1925).
4. Phillips, M., "Wood Chemistry," edited by L. Wise, pa 648 (1944).
5. Schwartz, H., McCarthy, J., and Hibbert, H., *Paper Trade* 111, No. 18: 30 (1940).
6. CCA 5, *Svensk Papperstidn.* 47: 8 (1944).
7. Brauns, F. E., *J. Am. Chem. Soc.* 61: 2120 (1939).
8. Pearl, J., *J. Am. Chem. Soc.* 7: 2196 (1949).
9. Harris, E., Saeman, I., and Bergström, C., *Ind. Eng. Che* 41: 2063 (1949).
10. Enkvist, T., and Hägglund, E., *Festskrift J. A. Hedwall* 1 (1948) (in German).
11. Enkvist, T., and Alfredsson, B., *Svensk Papperstidn.* 54: 1 (1951) (in German).
12. Richtzenhain, H., *Svensk Papperstidn.* 53: 644 (1950) (German).
13. Brode, W., "Chem. Spectroscopy," 2nd ed, page 4 (1943).

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Chlorine Dioxide for Odor Control

ERIC R. WOODWARD

The use of chlorine dioxide in a limited number of industrial plants which are notorious for the discharge of obnoxious odors has met with success on a commercial scale. The effluent gases contain methyl and ethyl amines, hydrogen sulphide, and mercaptans. Moreover, this particular problem is one which, over the years, has not been solved by the use of chlorine. It appears, therefore, that this is one more case where chlorine dioxide yields a specific result which is not accomplished by either chlorine or oxygen alone. As with any other chemical remedy, efficient contact between chlorine dioxide and the offending odors is essential. This involves proper ventilation of buildings where the odors originate, adequate collection and transfer of the odor bearing medium to the point of treatment, and efficient scrubbing of the odorous materials before release to the surrounding atmosphere or terrain.

The title of this paper is purposely broad because when asked to present a discussion of the subject before this meeting the author protested that his work on odor control, so far, has been confined to other industries. However, as business is conducted today, ideas are the forerunners of progress, and so the author would like to present for consideration his ideas on the value of chlorine dioxide for reduction of kraft mill odors.

If one sets out to find the most objectionable industrial odors today one might well arrive at the conclusion that animal fat and fish rendering plants qualify for first place. Attempts to destroy these odors have, until recently, met with indifferent success. As far back as 1922 Henderson and Haggard were granted a United States patent for their process which is described as: "deodorizing offensive gaseous emanations from organic matter." Their method was to use chl rine gas to destroy the odors. It was tried widely in th industry, and chlorinators, which were installed in man plants in the belief that a solution to the problem ha at last been found, are now standing idle.

Chlorine dioxide is not new to the pulp and pap industry, since all are familiar with its use as a bleac ing agent in the production of high brightness pul A search of the literature, however, indicates that th idea of applying chlorine dioxide to reduce kraft mi odors is new. The author will present, therefore, som of the information available, based on experience of th use of chlorine dioxide for odor control in other field draw some analogies between that work and the presen subject, and suggest how chlorine dioxide can be trie in pulp and paper laboratories or mills.

PRESENT USES OF CHLORINE DIOXIDE FOR ODO CONTROL

In the public waterworks serving cities and towns the vicinity of steel mills, coke ovens, and chemic plants, the water supply is contaminated with traces phenol. When the water is sterilized by chlorination, most disagreeable taste and odor are imparted to it. some localities this is so strong that a person can taste in coffee or tea, at home or in a restaurant. The tas is due to the combination of chlorine and phenol, forn ing chlor-phenol. Chlorine dioxide is a specific remed for this taste and odor. It is believed that this is due oxidation which destroys the objectionable taste ar odor, or prevents their formation.

Another cause of taste and odor in public water su plies at certain seasons of the year is due to alga After algae growths have been killed by copper su

Eric R. Woodward, Mathieson Chemical Research and Engineering Div., Mathieson Chemical Corp., Baltimore, Md.

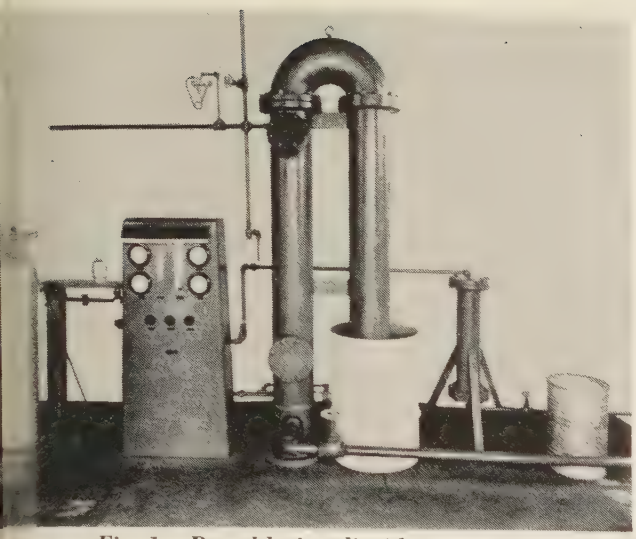

Fig. 1. Dry chlorine dioxide generator

...te, or some other treatment, an essential oil from the ...anism is carried along and gives the water an ob...ionable musty taste and odor. If the attempt is ...le to destroy this with excessive amounts of chlorine, ...ecomes still more objectionable. Here again, chlo... dioxide is a specific remedy.

In animal fat and fish rendering plants, soap works, ... fat splitting plants, the volatile materials causing ...ectionable odors are principally monoethylamine; ...iethylamine; triethylamine; the mono, di, and tri...ethylamines; ammonia; hydrogen sulphide; mer...aptans, and other volatile sulphur compounds. Ex...rience shows that chlorine dioxide destroys or greatly ...duces these odors, while chlorine is chiefly effective in ...dor reduction where it can sterilize waste organic mat...r thereby retarding its decay.

CHLORINE DIOXIDE VERSUS CHLORINE

In seeking a chemical explanation for this difference ... behavior of chlorine and chlorine dioxide, it is be...ved that the reason is that chlorine treatment of ...lors produces substitution products, while chlorine ...oxide treatment oxidizes without chlorinating. There ... ample evidence in the literature to support this theory. ...s all know, one of the cheapest ways to generate ...lorine dioxide gas is by the action of an acid on chlo...te. In 1937 Vincent (*1*) patented a process for the pro...uction of chlorine dioxide by the reaction of an alkali ... alkaline earth metal chlorate in acid solution. Later ... 1937 Cunningham (*1A*) was granted a patent for the ...oduction of chlorine dioxide from a metal chlorate in ... aqueous solution containing 25 to 100 parts by ...eight of the chlorate for each 100 parts of water in the ...esence of sulphur dioxide gas mixed with an inert gas ...luent. In the early 1940's Holst (*2*) showed that an ...proved yield of chlorine dioxide could be obtained ...om the above process by adding a relatively high con...ntration of sulphuric acid to the chlorate solution ...efore the reaction with sulphur dioxide. By working ...th a chlorate-sulphuric acid-water solution of highest ...ossible concentration with respect to both chlorate ...d acid, it is possible to obtain a very high yield of ...lorine dioxide by the use of sulphur dioxide as a re...cing agent. In this reaction as much as 90% of the ...lorate is efficiently utilized. The evolved chlorine ...oxide is practically free from chlorine.

Evidence regarding the fact that chlorine dioxide oxidized without chlorinating is found in the following literature references (*3, 4, 5*). Using a catalytic method, Hofmann found that osmium tetroxide greatly increased the activity of chlorate solutions. Some of his work was done in neutral and some in acid solution. A good many compounds which are not readily attacked by chlorate and acid alone are oxidized in the presence of this catalyst. He was able to identify a good many of the reaction products. Oxidation but no chlorination takes place, and there is less destruction of the molecule than is ordinarily the case. He used rather dilute solutions of the organic substances to be oxidized. The amount of osmium tetroxide varied from 0.01 gram per 200 ml. to 1.5 gram per 100 ml. of solution.

Milas and Terry (*6–9*) have used and improved Hofmann's method. In their work they used vanadium pentoxide as catalyst in some of their experiments in place of cadmium tetroxide. Low molecular weight acids, from methyl to isoamyl, give good yields of the corresponding esters. Yields up to 97% are obtained in some of the reactions, as, for example, in the oxidation of maleic and fumaric acids to mesotartaric and racemic acids.

Schmidt, Haag, and Sperling (*10*) studied the reactions of a number of phenols, and other organic compounds, with chlorine dioxide. Their technique differs from Schmidt's earlier work inasmuch as the reactions are carried out in the presence of a catalyst. They claim that the catalyst reduces the number of products and simplifies the reaction, but that substances indifferent to chlorine dioxide alone are not attacked. They found that chlorine dioxide attacks the benzene ring when it contains a hydroxyl group. The breaking of the ring gives primarily carbon dioxide, oxalic acid, and maleic acid. This is another example where chlorine dioxide gives oxygenation without chlorination.

Milas (*11*) reports that: (1) vanadium pentoxide induces the oxidation of furfural and pyromucic acid with chlorates to give fumaric acid as the principal product, (2) osmium tetroxide also induces the oxidation of furfural and pyromucic acid with chlorates to give mesotartaric acid as the principal product, and oxalic acid as the

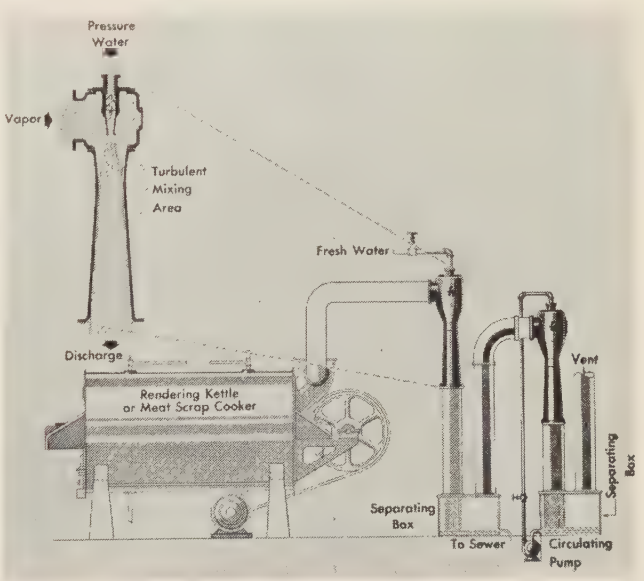

Fig. 2. Vapor condenser for rendering kettle or meat scrap cooker

by-product, (3) the mechanism of the reaction has been worked out, and maleic acid aldehyde has been isolated as the intermediate product.

Later, Milas (*12*) reports on catalytic oxidations in aqueous solutions, II, the oxidation of primary alcohols. A new catalytic method is described whereby the primary alcohols are simultaneously oxidized and esterified. It consists in the treatment of the alcohols, under proper care, with chlorates in dilute acid solution, and in the presence of vanadium pentoxide as the catalyst.

The above examples clearly establish the oxidizing, or one might preferably say the oxygenating properties of chlorine dioxide.

A further example of the difference in behavior of chlorine and chlorine dioxide is found in their reactions toward ammonia. Chlorine reacts directly with ammonia to form white clouds of ammonium chloride, whereas chlorine dioxide does not. This fact is used when operating dry chlorine dioxide generators to determine when the chlorite charge is spent (see Fig. 1). In these generators a stream of chlorine gas diluted with a stream of air is passed upward through a reaction tower which is packed with sodium chlorite. So long as all of the chlorine is reacting with chlorite and only chlorine dioxide and air are coming out, no fumes are visible at the sampling line outlet when the offcoming gas is tested with aqua ammonia. When the charge of chlorite is nearly spent, some chlorine goes through the tower unreacted, and white fumes of ammonium chloride appear at the outlet. This indicates that the tower should be re-charged with sodium chlorite.

In treating rendering plant odors, a significant result of this fact is that the presence of ammonia does not reduce the strength of the chlorine dioxide which is therefore free to oxidize foul odors. Chlorine, under these circumstances, forms ammonium chloride and chloramines and is therefore not available for odor control. Rendering plants and many other industrial plants which treat organic materials give off ammonia as a protein degradation product. This creates alkaline environment in the closed water absorption system, and

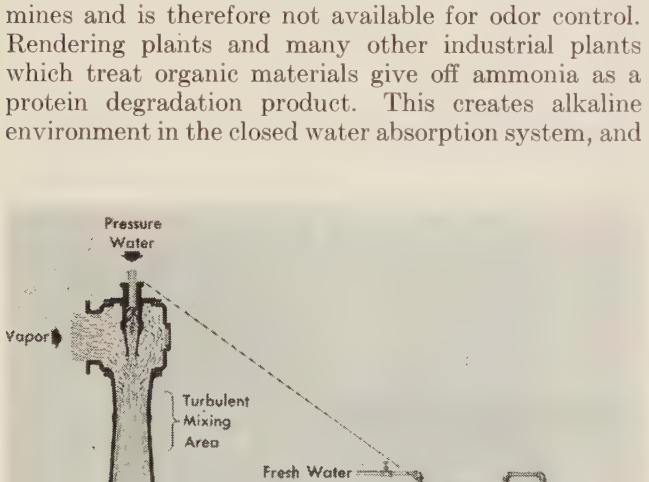

Fig. 3. Fume scrubber for fish rendering plant

in the effluent gases discharged to the atmosphere. Chlorine is chiefly active as a deodorant in an acid medium, whereas chlorine dioxide is an effective deodorant in acid, alkaline, or in a neutral medium. In fact, chlorine dioxide has its highest oxidation potential on the alkaline side.

Chlorine dioxide is found to be effective in destroying the cooking odors in animal fat (Fig. 2) and fish rendering plants (Fig. 3). Commercial usage in several plants of this type in which chlorine had failed to destroy the obnoxious odors, demonstrates the effectiveness of chlorine dioxide. The action of chlorine dioxide is permanent and not just a temporary masking effect.

It would appear, therefore, that the essential difference between the reactions of chlorine and chlorine dioxide in odor control processes stems from the fact that chlorine dioxide oxidizes obnoxious vapors without chlorinating them, whereas chlorine forms chlorine derivatives or substitution products. The efficacy of chlorine dioxide may therefore be attributed to the fact that oxygenation of obnoxious odors is essential if they are to be destroyed or made inoffensive.

Following is a limited amount of data on a few reactions of chlorine dioxide with inorganic and with organic sulphur compounds, also the reaction between sodium chlorite and sulphur.

The oxidation of sulphur and of sodium sulphite by chlorine dioxide in alkaline solution is shown by the following equations:

$$6ClO_2 + S + 8NaOH = 6NaClO_2 + Na_2SO_4 + 4H_2O \quad (13$$

$$2ClO_2 + Na_2SO_3 + 2NaOH = 2NaClO_2 + Na_2SO_4 + H_2O \quad (14$$

Moreover, sodium chlorite reacts with sulphur in a unique manner. A mixture of sulphur and solid sodium chlorite will ignite if rubbed, or if it is slightly moistened. There is enough sulphur in a rubber stopper to cause a slight pop when rubbed on moist chlorite. Bottles containing chlorite should be closed with cork or glass stoppers. The wearing of articles of clothing made of sulphur-bearing rubber is hazardous for an operator handling chlorite. The substitution of neoprene removes this danger.

Regarding reactions of chlorine dioxide with organic sulphur compounds, Schmidt reported in 1922 that chlorine dioxide reacts with mercaptans, also with dialkyl sulphides (*15*). The above examples illustrate the powerful and preferential oxygenating effect of chlorine dioxide.

General experience points to the fact that oxidation is the most effective means for destroying or changing obnoxious industrial odors. Methods based on this principle can be classified under the headings: burning, catalytic combustion, and chemical reaction. It is the third of these methods, namely chemical reaction, that we are considering in this paper.

OXIDATION THE REMEDY FOR KRAFT MILL ODOR

In the January, 1952, issue of *Pulp and Paper*, R. H. Wright (*16*) reports on a Canadian kraft industry odor control project. This appears to be coincidental with the work of Weyerhaeuser Timber Co. as reported by Gerritt G. DeHaas in *Pulp and Paper*, December 1951 (*17*). This process is described further in an article entitled "Tower Oxidizes Odors Away" which appeared in the September, 1952 (*18*) issue of *Chemical Engineering*.

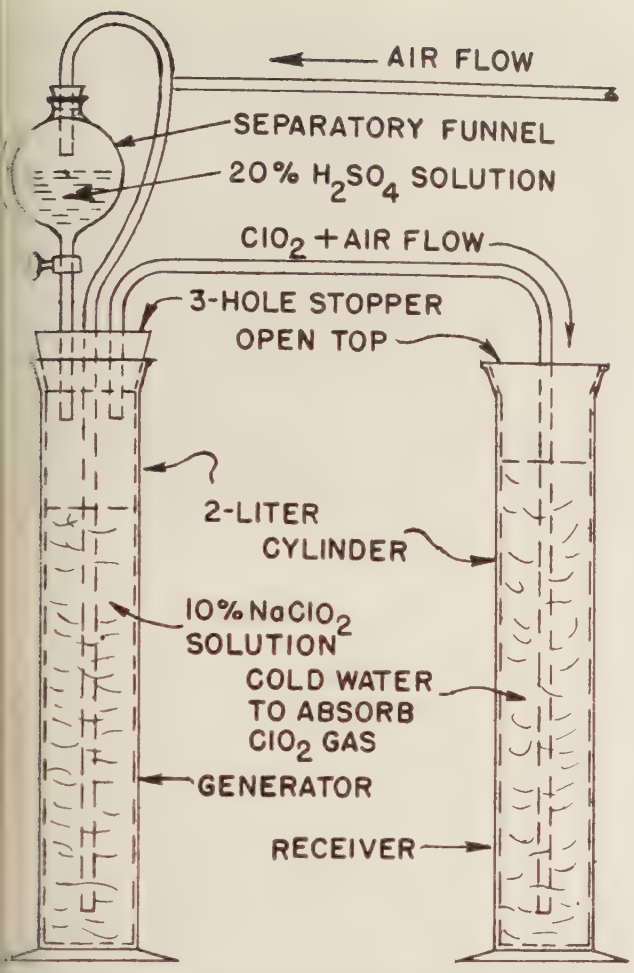

Fig. 4. Laboratory type wet chlorine dioxide generator

After setting up the chlorine dioxide generator as shown, turn the air supply sufficiently to cause moderately vigorous agitation in the generator and receiver. From the separatory funnel, carefully add a few drops at a time of sulphuric acid. After a short time the chlorite solution in the generator will become saturated with chlorine dioxide gas and the excess will then continue to pass over into the receiver where it will be absorbed in the water at room temperature to a concentration of about 3 grams per liter (3000 p.p.m.) available chlorine.

If instead of making up batches of chlorine dioxide water, it is desired to treat an oil or other liquid with chlorine dioxide gas, the receiver may be filled with the liquid to be treated and the gas and air may then be bubbled through it at any desired rate of flow.

Because of the likelihood that some chlorine dioxide gas will escape out of the open top of the receiver this operation should be conducted under a hood.

As a safety precaution when starting the generator, be sure to have an air stream passing through it before and during the addition of acid, also throughout the operation.

When shutting down, after the acid is shut off, keep the air flowing until the solution in the generator is colorless.

These articles explain that the release of foul odors has been a major defect of the kraft pulping process ever since its development more than 60 years ago. The principal malodorous substances, hydrogen sulphide, mercaptans, organic sulphides, and disulphides, are all readily volatilized.

It is stated that the first important step toward an effective solution of the problem was made some years ago when Bergstrom and Troebeck showed that "black liquor oxidation" was effective in reducing the release of odor in the multiple effect and cascade evaporators. The object of the operation is to fix volatile sulphur compounds in the liquor by oxidizing them to less volatile derivatives.

In the most recent article mentioned above, a description is given of the operation of an oxidizing tower at Springfield, Ore., which is removing offensive odors escaping from the cooking liquors in the kraft pulping process. The process accomplishes this result by oxidizing the volatile and odorous sulphides in the spent cooking liquor to more stable thiosulphates.

Under the heading "simple air oxidation" this same article states: "Knowing that these volatile sulphur compounds could be oxidized to more stable compounds by bubbling air into the liquor, Weyerhaeuser researchers set out to learn just how much air was needed."

As the author read this it struck a familiar note because, for a long time, it was known from experience with such operations as bleaching glyceridic esters (U. S. pat. 2,473,930) (*19*), the bodying of vegetable oils, and the oxidation of petroleum hydrocarbons (U. S. pat. 2,573,751) (*20*) that a mixture of chlorine dioxide and air is a much stronger oxygenating agent than air alone.

It is believed therefore, that in these oxidizing towers for the destruction of kraft mill odors the enrichment of the air stream with chlorine dioxide gas in amounts giving a partial pressure of 30 mm. of mercury or less may be well worth consideration.

Also where closed system scrubber towers are used to wash the odors out of noncondensable gases from the multiple effect evaporator of the recovery system, dosing the wash water with chlorine dioxide gas to maintain a 20 to 100 p.p.m. residual of chlorine dioxide might prove to be an effective deodorizing remedy.

METHODS OF GENERATING AND APPLYING CHLORINE DIOXIDE

In order to determine the effectiveness of chlorine dioxide in your own plant it is of course necessary to have some simple and inexpensive means of doing so.

Chlorine dioxide can be obtained in pure solution for laboratory use by adding a weak solution of sulphuric acid to a sodium chlorite solution, and then sweeping the gas into distilled water by a stream of air. This produces an un-ionized and highly colored solution which remains stable at refrigerator temperatures. At

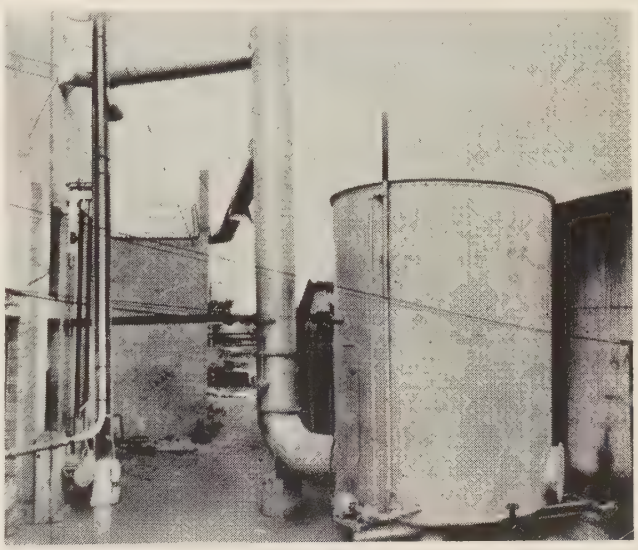

Fig. 5. Scrubber tower in a rendering plant using chlorine dioxide water

room temperatures it decomposes gradually to a colorless solution.

Two methods of generating chlorine dioxide from chlorite are:

I. Chlorine activation—
$2NaClO_2 + Cl_2 = 2ClO_2 + 2NaCl$ (wet or dry generator)

II. Acid activation—
$5NaClO_2 + 2H_2SO_4 = 4ClO_2 + 2Na_2SO_4 + NaCl + 2H_2O$ (wet generator)

Starting out, therefore, on the laboratory scale, the simplest way to generate small quantities of chlorine dioxide is shown in Fig. 4. A 10% solution of sodium chlorite is made up in a 2-liter cylinder. A three-hole cork holds an air inlet tube, a separatory funnel, and an air and gas outlet tube. A 20% solution of sulphuric acid is contained in the funnel. When ready to use the chlorine dioxide gas, turn on the air to give moderate bubbling in the left-hand cylinder or generator, then run acid slowly, a drop at a time, into the chlorite solution. In a very short time the solution will turn a greenish yellow color, indicating the presence of chlorine dioxide. The air passing through it will strip out the chlorine dioxide gas and transfer it to the water in the right-hand cylinder or receiver. Aqueous solutions of chlorine dioxide can be made up in this way to a concentration of 3 grams per liter at room temperature.

If a slow stream of the odorous vapors is passed up through a small scrubber tower and chlorine dioxide water sprayed into the tower in intimate contact with the vapors, some indication of its effectiveness can be observed. The velocity of the stream of vapors passing through the tower should not exceed 250 f.p.m. The concentration of chlorine dioxide in the water may be varied from 20 to 100 p.p.m. or more, and the water flow can be regulated to give optimum results.

For pilot plant tests, or for full plant scale operations, a wet generator based on the method of acid activation

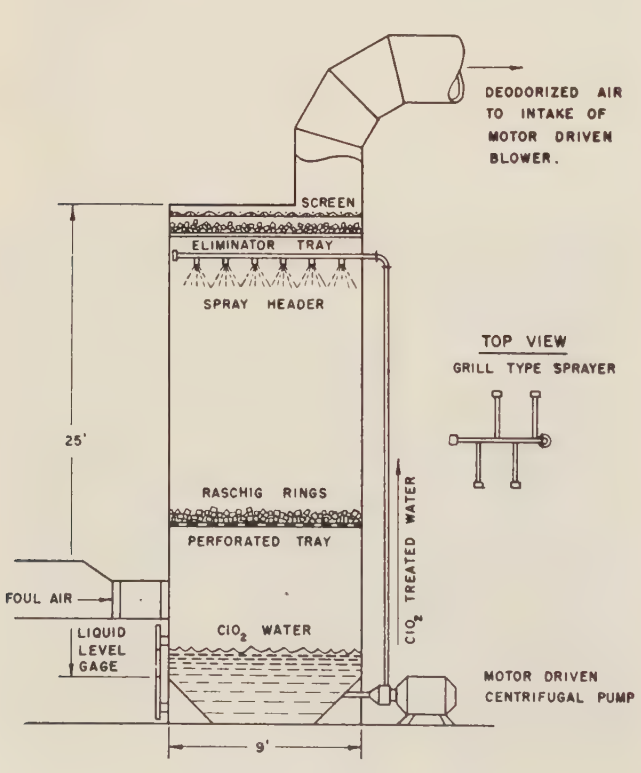

Fig. 6. Scrubber tower. Chlorine treated water system for odor control in rendering plants

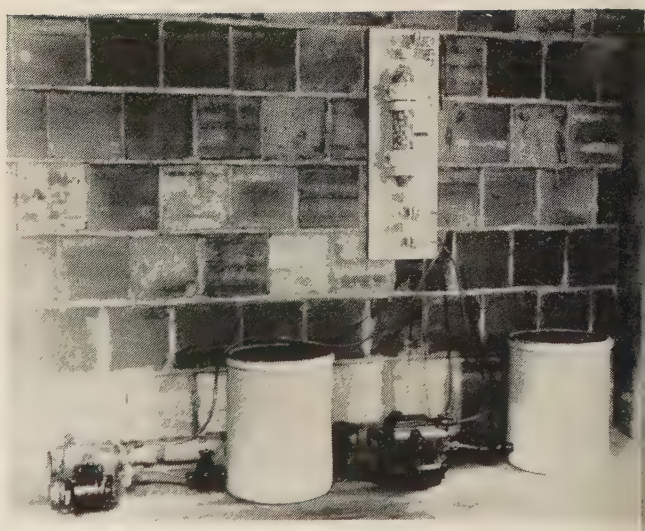

Fig. 7. Chlorine dioxide wet generator (acid activation

of sodium chlorite may be used. This of course is on the assumption that a chlorine dioxide generator for the bleaching of pulp has not already been installed in the plant (Fig. 7).

This chlorine dioxide generator consists of a Pyrex glass mixing chamber packed with Raschig rings. The two crocks contain sodium chlorite solution and sulphuric acid solution, respectively. Characteristic concentrations for making up these solutions can be 1 lb. sodium chlorite per gal. of water, 1/4 lb. of 66° Bé sulphuric acid per gal. of water. The best pH for efficient generation of chlorine dioxide by this method is 2.8. Two proportioning pumps with plastic heads take suction from the crocks and force the two solutions at a slow rate, for example, 1 gal. per hr. through plastic tubing to the base of the mixing chamber, and through it to the point of application of the chlorine dioxide solution. In passing through the mixing chamber the chlorite and acid solutions react to produce chlorine dioxide in aqueous solution. This solution can be fed into a sump containing scrubber tower water which is being recirculated, or it can be used to treat condenser water which is being recirculated through jet condensers or spray nozzles in a closed system.

Alternatively the chlorine activation method can be used (Fig. 8).

The operation of the chlorine dioxide generator can be intermittent as it is only necessary to maintain a certain concentration of chlorine dioxide gas in solution in the re-cycled water.

Should it be desirable to use dry chlorine dioxide gas diluted with air this can be done by using the dry chlorine dioxide gas generator (see Fig. 1).

The dry generator (*21*) produces chlorine dioxide gas diluted with air and operates on the principle of chlorine activation of sodium chlorite. The reaction tower is charged with 100 lb. of dry sodium chlorite. A mixed stream of dry air and chlorine gas is passed upward through the tower in intimate contact with the chlorite charge. Reaction proceeds in accordance with the equation:

$$2NaClO_2 + Cl_2 = 2ClO_2 + 2NaCl$$

so that the stream leaving the top of the reaction tower

Fig. 8. Chlorine dioxide wet generator (chlorine activation)

composed of chlorine dioxide and air uncontaminated with free chlorine.

The operation is safe so long as the proportions of air and chlorine are kept within proper limits. It is recommended that 50 volumes of air or more be fed through the generator for 1 volume of chlorine gas. This results in a partial pressure of 25 to 30 mm. (of mercury) for chlorine dioxide in air.

A number of these units are being operated in rendering plants for the bleaching of tallow. Chlorine dioxide gas from this generator can also be used to charge scrubber water or condenser water for odor control.

CORROSION

Chlorine dioxide water is corrosive to steel, stainless steel, aluminum, and other metals. It is essential, therefore, that equipment wetted by it be adequately coated with asphalt paint or other corrosion-resistant coating. Synthetic rubber, several of the plastic materials, and, of course, ceramics and glass are resistant to it.

OTHER CONSIDERATIONS

In any scheme for odor control in an industrial plant, problems of ventilation of buildings where the odors originate, adequate collection and transfer of odors to point of treatment, and efficient contact between the odors and the treating medium are of course paramount consideration. The equipment required to effect these operations is generally the most expensive part of an efficient odor control system, but it is essential because no matter how efficient in principle the chemical odor control method is, it cannot work to full advantage unless it is applied correctly and completely to all points in the plant where foul odors originate.

It is believed, therefore, that with proper application, chlorine dioxide can make an important contribution to the amelioration of kraft mill odor problems.

LITERATURE CITED

1. Vincent, U. S. pat. 2,078,045 (April 20, 1937).
1A. Cunningham, U. S. pat. 2,089,913 (Aug. 10, 1937).
2. Holst, U. S. pat. 2,373,830.
3. Hofmann, K., *Ber.*, 20: 593 (1913).
4. Hofmann, K., *Ber.* 45: 3329–3336 (1912).
5. Hofmann, Ehrhart, and Schneider, *Ber.* 46: 1657–1668 (1913).
6. Milas, N. A., *J. Am. Chem. Soc.* 49: 2005 (1927).
7. Milas, N. A., *J. Am. Chem. Soc.* 50: 493 (1928).
8. Milas and Terry, *J. Am. Chem. Soc.* 47: 1412 (1925).
9. Terry and Milas, *J. Am. Chem. Soc.* 48: 2647 (1926).
10. Schmidt, Haag, and Sperling, *Ber.* 58: 1394–1403 (1925).
11. Milas, N. A., *J. Am. Chem. Soc.* 49: 2011 (1927).
12. Milas, N. A., *J. Am. Chem. Soc.* 50: 493 (1928).
13. Jacobson, Encyclopedia of Chem. Reactions.
14. Vincent, U. S. pat. 2,092,944 (Sept. 14, 1937).
15. Schmidt and Braunsdorf, *Ber.* 55: 1529–1534 (1922).
16. Wright, R. H., *Pulp and Paper*, p. 89 (Jan., 1952).
17. DeHaas, Gerritt G., *Pulp and Paper* (Dec., 1951).
18. *Chem. Eng.*, p. 232 (Sept., 1952).
19. Woodward, U. S. Pat. 2,473,930 (June 21, 1949).
20. Woodward, U. S. Pat. 2,573,751 (Nov. 6, 1951).
21. Woodward, Petroe, and Vincent, *Trans. A.I.Ch.E.*, pp. 271–290 (June 25, 1944).

Received Nov. 14, 1952. Presented at the Sixth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Mobile, Ala., Nov. 12–14, 1952.

Experiences with Field-Applied Inconel Digester Linings

S. J. BAISCH

An experimental attempt was made to solve the digester corrosion problem by field lining a digester with 1/8-in. thick Inconel strip. The experiment was later expanded to include two digesters of the tumbling type. This report tells of the experiences of the one vessel having 2 1/2 years of lining service and the other a little over 1 year. The results show that excessive cracking has occurred in the welds adjacent to the Inconel strip and that a scale formation is taking place between the lining and the carbon steel backing of the digester. Believing that excessive temperature differential was occurring between liner and steel, a method for measuring temperature behind liner in carbon steel backing and outside of carbon steel shell, with the aid of pencil-type thermocouples, is given. In general, the alloy Inconel, has shown excellent corrosive resistance to alkaline pulping liquors, but further consideration must be given to a welding procedure to seal the liner to the carbon steel shell of the digester.

Actual experiences with tumbling digesters field lined with Inconel strips are presented. It is concluded that the alloy, Inconel, has excellent corrosion resistance to pulping liquors, but more study is required to develop a welding procedure to successfully retain the strip tightly to the digester interior wall.

The purpose of this paper is to merely summarize

S. J. Baisch, Design Engineer, Thilmany Pulp & Paper Co., Kaukauna, Wis.

experiences and endeavor to draw tentative conclusions with field-applied Inconel-lined tumbling digesters at the Thilmany Pulp & Paper Co. in Kaukauna, Wis. Such conclusions are necessarily tentative since it is premature to make final conclusions in that the performance with Inconel field linings has not been extensive to date. The observations presented herewith occurred in two field-lined digesters, one having been in service some $2^1/_2$ years, the other slightly over 1 year.

To start with, mention should be made concerning the selections of the alloy Inconel, and the methods employed in field lining the two vessels under consideration. A complete treatise on this subject was presented in a paper entitled "Corrosion and Field Lining of Sulphate Digesters" (*1*), published in February, 1951. It was pointed out therein that since field installation of alloy linings in pressure vessels of similar conditions, namely, 125 p.s.i. working pressure and 365°F., had been successfully carried out in other industries, particularly in the petroleum industry, and in a sulphate pulp mill in Australia, that it was recommended to our management that one of our vessels be lined as an experiment. Circumstances later allowed the experiment to be expanded to include two digesters.

SELECTION OF ALLOY AND LINING PROCEDURE

Inconel was the alloy selected because of its reported excellent resistance to corrosion of sulphate pulping liquors, and because of its coefficient of expansion being almost equal to that of carbon steel (*2*).

The procedure for applying the lining comprised the preparation of the digester, the fitting up of the Inconel strips, the welding to the carbon steel digester walls, and finally the testing for soundness and tightness of the lining.

Briefly, the preparation of the digester included sandblasting the interior, chipping and grinding off projections, and filling in depressions. The fitting of the hot-rolled, annealed, and pickled $^1/_8$-in. thick Inconel sheet, cut to 6 by 48-in. strips was accomplished with the aid of a hydraulic jack, the base of which was contoured to the cylindrical shape of the digester wall. A single fillet weld bead, using Inconel "132" coated electrodes, was laid along the edges of each strip and after testing for tightness, another bead was laid to cover the fillet welds between two adjacent strips.

TESTING LINING

The procedure used for testing was duplicated in the case of both digesters except a secondary or final test was adopted for the second digester.

The regular test consisted of applying 15 p.s.i. air pressure behind each strip, before the third, or cover welding bead was applied, and at the same time washing the welds with a weak soap solution. The formation of bubbles readily detects any flaws in the fillet welding.

Upon the suggestion of representatives from the International Nickel Co., a secondary or final test was given to the second field-lined digester before it was put into service. This test consisted of the following steps in sequence:

1. The digester was closed, void of content, and 125 p.s.i. steam was applied while the vessel was being tumbled at its regular rate for 1 hr. duration.
2. The steam was released through the blow valve and procedure one above was repeated, and again the steam was released.
3. After allowing the vessel to cool the lining was inspected for any defects, such as strips bulging and pits or cracks in the weldments.
4. One ounce of "Uranine WSS" aniline dye was added in the vessel and steam pressure slowly applied to 125 p.s.i. while tumbling at the regular operating speed.
5. The steam was released, carrying with it the major portion of the dyestuff since the dye material was also in a vapor state.
6. The digester was allowed to cool down for a few hours, the cover was removed, and the inside surface of the Inconel lining was washed down with steaming hot water.
7. Again the digester was closed and steamed to its service pressure while being tumbled for about 1 hr.
8. Steam was released very rapidly so as to create the maximum pressure differential between the inside of the digester and behind such strips of lining which were not entirely free from minute leaks or hermetically sealed to the steel shell.
9. After cooling down the digester lining and weldments were inspected with an ultraviolet light, and any defects were noticeable due to the fluorescence of the dyestuff which had seeped back.

EXPERIENCES IN FIRST DIGESTER

Approximately 6 months after being placed in service a thorough inspection of the Inconel lining and weldments was conducted. Back leakage of black liquor through the lining weldments in several pinholes and three hairline cracks immediately adjacent to the fillet welds was readily noted. Closer examination revealed other circumferential cracking along the edges of the welds, so, therefore, it was decided to hammer test each strip for other defects.

A total of 52 additional hairline cracks ranging in size from 1 to 14 in. in length were found. With the exception of one crack in the center of the weld, the other 54 appeared along the edges of the fillet weld, the source of each appeared at a point where undercutting takes place during the welding operation.

Since the productive capacity of the mill would have been seriously hindered at the time by removing the digester for repairs, it was decided to forego repairs and place the vessel back in service.

Various theories were discussed by members of the insurance carriers, representatives of the International Nickel Co., and the technical department into the cause of the weldment cracking. One of the theories which seemed pretty logical was that excessive stressing between the lining and carbon steel backing was taking place because of the temperature differential taking place during the cooking cycle between the lining and the carbon steel backing. This was occurring because of the insulating effect of the air space, regardless of how small, especially where the lining does not fit snugly the roughened and irregular carbon steel.

As a result of discussion it was decided to measure, with the aid of pencil-type thermocouples, the actual temperatures existing in the digester, behind the lining, in the carbon steel backing plate, and between the car-

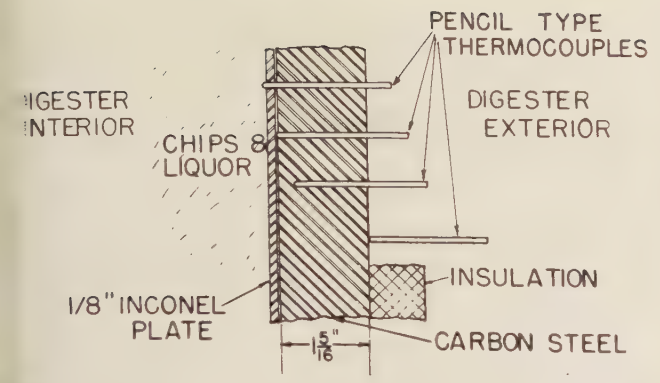

Fig. 1. Location of pencil thermocouples in digester shell

on steel and the outside insulation. Four pencil-type thermocouples with their hot junctions on the tip were selected, and the temperature readings were taken during three cooking cycles. The temperatures measured were in the trunnion or middle shell course section of the digester (Fig. 1).

The maximum temperature differential observed between the interior of the digester and the exterior of the carbon steel shell during this test was 49°F., and this occurred while the digester was being charged with chips and liquor, and in this particular charge the hot liquor was added later than usual (Fig. 2). The normal procedure is to add both the liquor and chips simultaneously.

Since carbon steel has a coefficient of thermal expansion 6.7 by 10^{-6} in. per in. per °F. and Inconel 6.4 by 10^{-6} in. per in. per °F. the thermal movement of the lining due to the 49°F. temperature observed in the test would be calculated $0.3 \times 10^{-6} \times 49$ or 0.0000141 in. per in. or for all practical purposes negligible.

Whenever production schedules allowed the time other inspections followed. By the removal of lining adjacent to cracks it was found that a scale formation was taking place between the liner and the carbon steel. Samples of this scale were sent to the International Nickel Co. laboratory, for analysis. The results of a wet chemical analysis showed the following per cent by weight: Fe, 24.9; S, 16.5; Na, 18.7. In addition to the wet chemical analysis they reported that a qualitative spectrographic analysis on the specimen indicated that nickel and chromium were present in small amounts, but that all other elements such as aluminum, barium, calcium, lead, lithium, manganese,

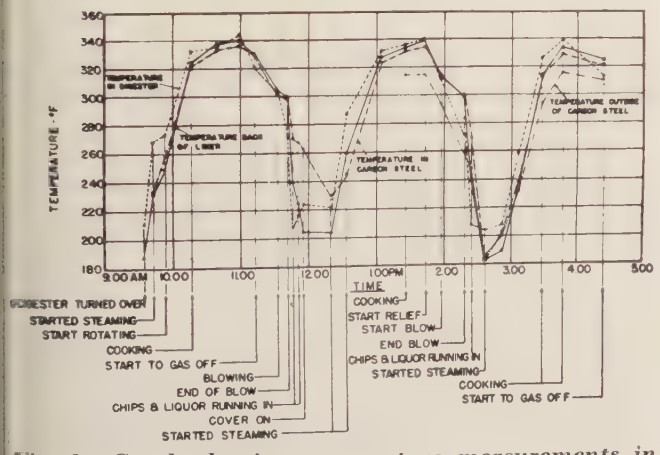

Fig. 2. Graph showing temperature measurements in digester lining and steel shell during cooking cycle

Fig. 3. Typical crack in Inconel strip weldment

potassium, silicon, etc., were either not found or present in only very slight traces.

One of the cracked weldments, together with pieces of the two adjacent Inconel strips, were sent to the laboratory for analysis. They reported that microscopic examination of the weld indicated that there was no evidence of faulty welding technique employed. The penetration was excellent and the line of demarcation between weld metal and parent metal was gradual and free from any boundary line cracking. It was further reported that, in their opinion, the failure occurred very shortly after the actual welding operation and even before the deposited metal had had time to cool below the oxide-forming temperature. Such a fracture could well be caused by thermal expansion or contraction and might be due to improper clamping or jigging during the actual welding operation. They felt that the fracture was due to a thermomechanical failure resulting from welding procedure.

One may conclude that if this were a thermomechanical failure it could be due to one or more of the following factors: (1) improper jigging or best fit-up; (2) fabrication design, i.e., orientation of the strips and their dimension thickness; and/or (3) cleanliness, freedom of steel shell from residual traces of sodium sulphate.

During a recent inspection a few more samples of cracked weldments were removed for further analysis. In the course of this inspection it was noted that after over $2^1/_2$ years of service the Inconel strip showed only a slight amount of corrosion. The original fabrication marks, such as strike marks for welding rod starts, chipping marks, etc., are still visible.

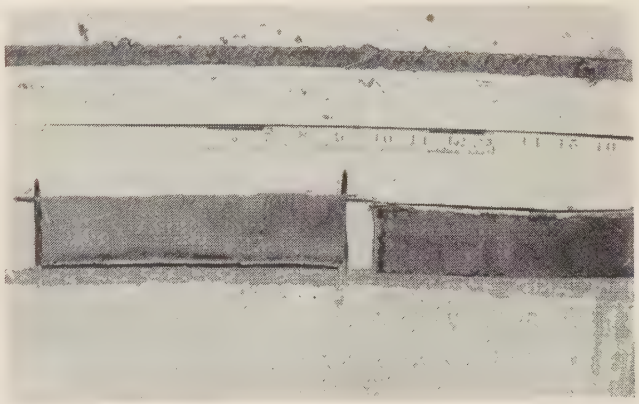

Fig. 4. Liner removed next to weldment crack—note scale formation

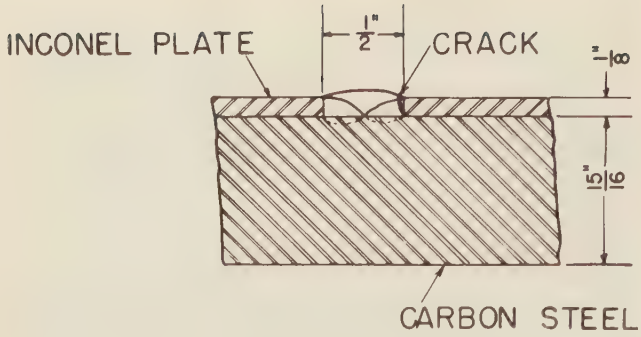

Fig. 5. Cross-sectional sketch of typical weldment crack

Removal of some dozen areas of lining and checking the thickness of carbon steel shell shows very little loss of metal during the $2^1/_2$ yr. period (Fig. 4).

A program of continued checking and surveillance has been adopted in the case of this vessel.

EXPERIENCES IN SECOND LINED DIGESTER

As mentioned beforehand, circumstances caused the field lining experimental program to include another digester. This was primarily due to the tight delivery of digesters during the years 1950–51, and in the fact that a used vessel was available in the yard of the plant. In order to get another digester into service as soon as possible, it was decided to install a new cone and to line with Inconel strip the used digester available. It was the consensus that it might now be possible to do a fairly successful job with a minimum of defects in the second unit.

The aniline dye test as outlined herein was employed in the final checking of this digester before being placed in service.

The first test revealed some 14 defects in the welds of the cylindrical section of the vessel, six of them were visibly short hairline cracks in the horizontal weldments and the balance were due to porosity in test hole weld caps. No leaks or cracks were found in the lined conical section.

The 14 defects were repaired by using Inconel sheet sectional overlays, thereby welding Inconel to Inconel. This type of repair has been very successful to date. After repair another aniline test was given, and since no further defects were noted the digester was placed in production.

After approximately 1 month of cooking service another dye test was carried out and the results showed up eight defects; four were in the welded test holes, three were hairline cracks in the weldment along the Inconel strip, and one was a pit in a weld. These defects were similar in nature to those found in the first digester. After repairs the digester again resumed cooking pulp.

Three months later it was again entered for another

Fig. 6. Photograph of typical Inconel weldment crack

Fig. 7. Undercutting along edge of Inconel strip and carbon steel shell of digester

inspection and this time some 15 defects were found; six pinhole leaks, six leaks in test hole welds, and three hairline cracks. These were repaired and once again the digester was placed on the line.

Approximately three more months of production time elapsed, and careful examination revealed some 26 additional typical hairline cracks varying in length from 1 to 15 in. They occurred in the middle or trunnion section of the digester where the maximum stresses occur during a cooking and tumbling cycle.

Removal of cracked liner showed that a scale formation was taking place between the liner and carbon steel on the carbon steel backing. Analysis of the scale disclosed it to be typically the same as found in the first digester.

Once again the necessary repairs were made and the digester was placed back into production.

The next and final inspection to the date of this report occurred after about three additional months and some 65 hairline cracks varying in size from 1 to 15 in. long were found, all of them present in the cylindrical section. Because of the greatness in number and the progressively increasing defects appearing it was decided to give up attempting to repair. From the commencement of lining the vessel up to this time some 63 flaws had been repaired.

A point of interest to be noted here is that, other than the two initial flaws found in test holes in the cone section at the beginning, that no other defects were detected in all of the other inspections. Whether any significance can be attached to this finding remains to the future. There are two facts of difference between

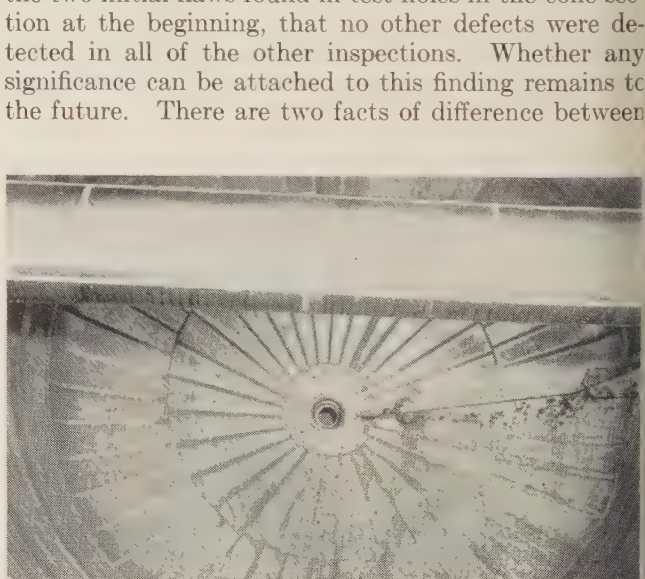

Fig. 8. Inconel lined cone after 1 year of service

he lining in the cylindrical section of the digester and ing in the cone section, and these are, first, the cone as newly made of virgin steel, never having been exosed to sulphate cooking liquors, and second, the ps of Inconel were placed parallel to the longitudinal xis of the vessel thereby resulting in the long strip elds being perpendicular to the long strip welds of the ylindrical sections.

CONCLUSIONS

From the experiences encountered thus far the following tentative conclusions may be made:

1. Inconel possesses excellent corrosion-resistant characteristics to sulphate cooking liquors since no measurable loss has been noticed.
2. Complete field lining of used sulphate digesters might eventually prove successful or at least practical from a fabrication and maintenance cost standpoint.

All experience to date at our mill indicates the need for more detailed study and experience on this subject, particularly with respect to: (a) modifications and improvements in fabrication technique and design, and (b) cleaning procedures adequate to remove all traces of residual liquor occluded on the used steel shell.

LITERATURE CITED

1. Collins, T. T., Jr., Baisch, S. J., and Vander Velden, G. T., "Corrosion and Field Lining of Sulphate Digesters," *Paper Trade J.* (February 9 and 16, 1951).
2. Teeple, H. O., *Paper Trade J.* 131, No. 19: 28, 30–32; No. 20; 19:23; No. 21: 14, 15, 18, 19, 21–25 (Nov. 9, 16, 23, 23, 1950).
3. International Nickel Co., Inc., "Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel." Technical Bulletin T-2 (1949).

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Design of Chimneys for Odor Dispersion

F. L. CATE

The problems of air pollution, and certainly odors can be considered a type of contamination, cannot be solved merely by building a chimney. A theory has been developed that at a distance of ten times the chimney height smoke concentration at ground level reaches a maximum. Concentration at that maximum varies inversely as the square of the chimney height, and at distances greater than 50 chimney heights the concentration varies as the inverse square of the distance and is independent of the chimney height. This tends to show that by doubling the chimney height, the maximum ground concentration would be materially reduced. However, regardless of height, some distant place will at some time be affected by the contamination being discharged. There are various means of eliminating more positively the odors and contaminants than by depending on a chimney of a certain height. Collectors of various types, both mechanical and electrical, where properly applied will eliminate to a great extent many injurious contaminants. A chimney alone is not the answer to odor elimination, but a chimney carefully designed for the service intended will aid in delivering the gases at a height so that when spread out over a certain area the ground concentration will be minimized.

In the preparation of this material reference is made to several articles dealing with this pertinent problem and especially to those papers written by George R. Hill and R. S. Steinbock. I also acknowledge, in particular, the valuable assistance given by F. L. Jordy with his more than 30 years of experience in chimney design and engineering.

It is sincerely desired that a prescription could be given for a chimney that would eliminate all obnoxious odors and troubles from that source; but despite the many articles written and theories propounded to indicate how a chimney can be made to solve such problems, all are probably aware that such problems are not fully resolved by one good chimney cure-all. However, there are approaches to this problem of odor dispersion, or elimination. These approaches, naturally, fall within the framework of the larger problem of air pollution, itself.

The intent of this paper is to point out what a chimney can do as regards odor dispersion and air pollution, and what can reasonably be expected from the most modern industrial chimney.

In designing a chimney for any purpose, the first consideration is the length of service before probable shutdown. Under proper operation, considering the maximum gas volume to be handled and the character and temperature of the gases, chimneys can be designed to operate, continuously if necessary, for their life.

To have a long life, a chimney must be definitely engineered and the proper material chosen for the service intended. In the best interest of the owner, chimneys should be "designed and built for at least the life expectancy of facilities they serve," and to fulfill this, a chimney must be designed to resist the operating conditions that will prevail. This demands selection of the proper size chimney which must: (1) be so sized and built of materials that will resist damage by erosion or corrosion; (2) resist high temperature or low temperature, whichever required; (3) resist acid or alkali, whichever required.

Basically, a chimney can be designed only to deliver the gases, fumes, or what the layman calls "smoke," into the atmosphere at a certain elevation. Upon leaving the chimney, the gases are acted upon by the atmosphere's "Four Horsemen" of dispersion. Of these, variable winds and wind turbulence, considered as one agent, are of first importance. Add to this, air velocity, temperature, and humidity and you have a combination forming a quartet of dispersing agents that can upset the functioning of a theoretically well-

F. L. Cate, Chimney Dept., The Rust Engineering Co., Birmingham, Ala.

designed chimney. Designed, that is, on some theory that size or type of chimney would be the answer to the problem of contamination—and it is believed that some history in this direction will be of interest.

As you know, industrial progress naturally has produced waste materials and contamination problems which are compounded and made more complex as our technical processes become more refined and of higher order. It is rather interesting to note what one might call the "evolution" of the contaminant process in this country from water . . . land . . . to air.

As we become aware of the nature of each new contaminant that appeared on our industrial scene, steps have been taken to counteract it. We, as a nation, have learned that we must purge the streams of contaminants if we would preserve the natural life therein; to clean the forests to prevent the destruction of the valuable supply of timber used for all purposes; and now we have come to the Atomic Age, where greater than ever before, the contamination of the atmosphere is realized because of the destructive nature of the gases that can be discharged from the chimneys serving the various plants engaged in the production of the basic materials for atomic energy and other important products.

Since the turn of the century thousands of chimneys have been built, discharging all types of waste gases into the atmosphere, and because of our rapid expansion and the colossal scale of recent plant development, the dumping of waste gases upon towns and cities, and agricultural communities throughout the country, has presented a very serious problem.

Yet even with this industrial increase, industry is not solely to be blamed for pollution—in fact industry is far from the greatest offender. The most universal offense, in the country, is caused by the odorous discharge of exhaust gases from motorized traffic.

A major condition has existed around the plants of the smelter industry and the paper industry as well as the rayon and other parts of the chemical industry for years.

There are records in the papers of the Bureau of Mines and in legislative documents as far back as 1864 where various cities enacted ordinances requiring that chimneys of manufacturing establishments be built to a certain height above adjoining buildings, thinking that by so doing, their problem of contamination, then called nuisance, could be eliminated.

In 1915, a scientific study (*1*) stated that the smoke from the smelter at Selby, Calif., was composed of three different classes of materials: dust, fumes, and gases. In the same year, the Bureau of Mines bulletin entitled "Metallurgical Smoke" defined smoke as "gases and vapors and the fine dust entrained by them that issue from the throat of furnaces, reverberatory smelting furnaces, roasting furnaces, etc." As time went on, further description was given to the contaminants as being pungent, obnoxious, offensive, disagreeable, noxious gases, noxious vapors, noxious acids, fumes, and soot—all are put on a nuisance and detrimental basis. The most common odorous gas is that of a sulphur base, but do not be mistaken, there are many odorous gases of different base. Sulphur gases are quite damaging since they will readily combine to form the various sulphur acids and these are instrumental in creating conditions destructive to property as well a to life and vegetation.

One of the largest smelter companies in the Unite States has carried on very extensive studies and experi mentations in an effort to improve odor eliminatio through smoke treatment. It was determined that th fumes contained not only sulphur gases but also, some times contained chlorine, arsenic and nitrogen. Al are very damaging and dangerous.

It was determined in the experimentation that sul phur dioxide fumes exhausted from a 200-ft. chimne (*2*) reached the ground in concentrated form grea enough to produce plant injury under critical condition all too frequently. The critical conditions are estab lished by the four agents of atmospheric dispersio mentioned earlier.

Another chimney 350 ft. high greatly improved con ditions, but at times the sulphur dioxide still persiste in sufficient concentration to become destructive So chimneys were built higher. Better dispersion wa expected. At a height of 450 ft. it was rare that ob jectionable concentrations reached the ground.

At this point, it might be said, that upon reaching a 450-ft. height, one might begin to be optimistic, ye there are cases on record, where it took 10 years fo people as much as 75 miles away from the plant t find out their crops were being affected by the con centrations that were settling to the ground. Thi would indicate that regardless of height, and unde certain critical conditions, there is a danger point some where far out along the line, and in time, its trouble may be traced back to the point of discharge.

Various auxiliary practices have been resorted t such as using a huge fan for blowing dilution air int the chimney. Other times, hot boiler gases were take into the chimney to increase the temperature, and there fore give the gases greater buoyancy. Experience ha demonstrated that the addition of normal air to an fume does dilute it and this is of material assistanc but it is by no means as effective as having an increas in temperature. If gases being handled by a chimne can be kept well above the dew point so that there wil be no condensed particles carried out and discharge with them, conditions are considerably benefited.

The result of the experiments conducted by a smeltin company proved that every degree of temperatur added to the fumes, was the equivalent of about $2^1/_2$ ft of additional chimney height so great is its effect o the buoyancy and consequent dispersion of the effluen gas.

So the main approaches to contaminant and odo dispersion through chimney design have been to in crease the chimney height; to dilute fumes by the ad dition of normal air; and/or to increase the velocit of the gases; and now we arrive at the governing facto in chimney building. For the nature of the gases t be handled at certain velocities will largely determin the design of the chimney and its lining.

The major consideration here is the character of th lining. This means a chimney column should tak all the flexural, oscillatory, torsion, and distortio stresses and be relieved of as much of the temperatu load as possible. The lining should be such as to resis the effects of the character of gases to be handled an serve as protection for the exterior column. Bes

neering practice acknowledges the acme of construction for any service is a chimney with an independent, self-supporting lining for the full height, built of the proper type materials for the purpose, separated from the main column by a free annular air space of varying width having a minimum at the top, depending on the height of the chimney. This is the type of chimney lining construction that has been adopted by the paper industry throughout the United States as best suitable to resist the effects of gases resulting from the operation of recovery boilers and in connection with any other process where destructive gases of either acid or alkaline nature or high temperature are to be handled.

The subject of type of construction of the chimney column itself will not be considered since that is a structural problem common to the design of any chimney and aside from variations in diameter and height has little bearing on our odor dispersion problem. However, the author should like to briefly touch on industry's trend of engineering thought and theory and approaches to the problem.

In November, 1949, the magazine *Industrial and Engineering Chemistry* published a symposium presented before the division of Industrial and Engineering Chemistry entitled "Atmospheric Contamination and Purification." It is a very interesting booklet and contains excellent articles. The *Chemical Engineering* magazine of February, March, and April, 1952, contains articles by R. S. Steinbock on the subject of stacks for pollution control. From these articles, much knowledge can be gained as to the theory for the dispersion of pollutants. The article in the symposium by M. B. Thomas, George R. Hill, and John N. Abersold of The American Smelting and Refining Co. entitled "Dispersion of Gases from Tall Chimneys" makes reference to the Bosanquet and Pearson presentation to the Faraday Society on the problem of dispersion of smoke from a single chimney, and Mr. Steinbock has also utilized the same reference on his theory of dispersion.

The symposium article deals with calculating the spreading of the smoke from a chimney, based on smoke stream or cloud fanning out both horizontally and vertically, forming a cone of dispersal smoke. The theory (*2*) is that at points close to the chimney, concentration is small, at distance ten times the chimney height, smoke concentration at ground level reaches the maximum. The concentration at that maximum varies inversely as the square of the chimney height. As the distance downstream increases until about 50 chimney heights the concentration varies as the inverse square of the distance and is independent of the chimney height.

It is claimed that by doubling the chimney height the maximum ground concentration can be reduced to 25%. This corresponding reduction does not prevail at great distances from the chimney. All of this is qualified by the four factors named previously, in particular, the velocity of gases leaving the chimney, difference between gas temperature and that of surrounding atmosphere, and greater change of air temperature with altitude. The first two determine the width of the plume and the last, over which there can be no control, determines maximum height to which the plume will rise.

In the second approach to the problem—the minimum height chimney or the stack designed to accommodate an increased velocity of gases as a means of better dispersion—is set forth in Mr. Steinbock's premise on stacks for pollution control.

He has taken the Bosanquet and Pearson theory of smoke dispersion from a single chimney, and injected into it a very careful study of meteorological conditions as to the atmosphere. Mr. Steinbock, by his study, endeavors to arrive at a calculated height of plume (*3*) and by a cut and try method, arrive at the minimum height of chimney so that the concentration at ground level, a certain distance from the chimney, will come within the allowable limitations for that district.

The theory back of these studies is very interesting and is deserving of consideration in our problem of odor dispersion. Nevertheless, in building a chimney, there must be a limit to the velocity of the gases traveling through the chimney without subjecting the chimney or the lining to internal pressure. The internal pressure will tend to force any condensation or even the deteriorating elements in the gases into the surface of the interior of the chimney whether it be of brick or concrete, or other material, and without a doubt, create a deteriorating effect which would tend to shorten the life of the chimney and this tends to nullify a main consideration in design of industrial chimneys—length of service before probable shutdown. In other words, there is the problem of increasing the maintenance cost. The soundest long range economy is to design and build chimneys that require the minimum maintenance, even at increased initial cost.

The velocity of the gases traveling through the chimney is a highly determining factor in efficient operation and in the reduction of maintenance for every chimney of a certain diameter has its own economic velocity.

Practical and sound engineering dictates that the maximum velocity in stacks 12 ft. in diameter and up, should be 35 f.p.s. This is the outflow velocity from the top of the chimney. There are cases, however, where the diameter of the chimney becomes quite large, that is 20, 25, even 30 and 40 ft. and in these abnormally large diameters, it has been suggested that the maximum velocity be limited to about 40 f.p.s., otherwise, a considerable pressure is liable to develop inside the chimney.

Now, in designing chimneys for more positive odor dispersion there are various measures that should be taken with either approach whether you depend on a chimney of a certain height, or the plume emanating therefrom through increased gas velocities. These measures are accomplished through the use of various types of equipment now marketed by many different manufacturers. For instance, collectors of different types; both mechanical and electrical; washers; or, in the case of many plants, the necessity for the erection of certain chemical apparatus to correct and eliminate the injurious contaminant.

Also, sometimes, through the chemical process, another product is made which can be marketed beneficially, and in this way rectify and justify the capital expenditure for such a chemical or oxidation plant.

The possibility of eliminating the odors chemically or by-oxidation which is actually a combustion process has been mentioned but that is, however, economically questionable.

For example, in the case of a fish-meal by-product plant on the West Coast where the fish were dehydrated, the fumes were so great when discharged into the atmosphere that sometimes the odor, necessary to determine the freshness of the fish, was destroyed. When they put in an incinerator and passed the fumes through the incinerator, burning them at a temperature of 1400°F., the fume odor was entirely eliminated.

Thus, there are two available means outside the industrial chimney, to eradicate obnoxious discharges: (1) by processing or by-product recovery, and (2) extraction of pollution by some means whereby their emission would be prevented. But, cost must be considered, and it will probably be found that using either of these odor eradication methods as an answer to a gas diffusion problem will not necessarily prove the most economical solution—and that is unfortunately too true of so many cure-alls.

However, it is known that a chimney of an effective height will aid in delivering the gases at a height so that when spread out over a certain area the groun concentration of odor or pollution will be minimized.

Further, experience teaches that it is far better t design a slightly higher stack to gain the effect of th increased height desired than to increase the velocit of the gases and depend upon the plume gaining tha height. It is true that this practical consideration wi cost some money. On the other hand, there is a gambl as to whether or not the actual theoretical attainment the plume will be realized.

In designing chimneys for pollution control and odo dispersion this gamble seems unwise when the othe approach to the problem is more certain.

LITERATURE CITED

1. Barkley, J. F., Chief, Fuels Utilization Branch, Bureau Mines, "Air Pollution Prevention in the United States."
2. Hill, George R., Thomas, Moyer D., and Abersold, John N Department of Agricultural Research, American Smelting Refining Co., "Hot Gases from High Stacks—A Practic Means of Overcoming Objectionable Concentrations Effluent Gases."
3. Steinbock, R. S., "Stacks for Pollution Control," *Chem. En* (March, 1952).
4. McCabe, Louis C., "Atmospheric Pollution," *Ind. Eng. Che* (Dec., 1951).

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Acid Pulping with Sodium Sulphate Liquors

GEORGE A. RICHTER

Soluble sulphates can be used as buffer material in place of sulphite salts in acid liquors for pulping wood. Thus solutions containing 2 to 4% sodium sulphate and 8 to 10% free sulphur dioxide will delignify wood chips in much the same manner as when the acid solution contains 1% combined sulphur dioxide. Many cases are cited to show the parallel behavior of these two types of liquor when used under a variety of conditions. Other sulphates than sodium have interesting possibilities.

Although it is readily demonstrated that wood can be successfully pulped with water solutions of sulphur dioxide alone, all commercial acid sulphite pulping is currently based on digestion of wood chips with liquor that contains both free sulphur dioxide and a bisulphite. Preferred use of bisulphite in the industry is explained by more practical operation, since in order to produce an easily bleachable pulp with sulphur dioxide alone it is necessary to employ high concentrations (15 to 25%) and to cook at high pressures and for longer periods of time than is found necessary when calcium or other bisulphites are present in the liquor.

The function of the bisulphite is not completely understood. There is considerable evidence that its main purpose is twofold: first, to protect the cellulose against excessive hydrolysis by the sulphurous acid and by the sulphonic acids formed in the sulphonation of lignin, and, second, to prevent loss of reactivity of lignin which can occur readily in the early stages of the cook in the absence of combined sulphite, particularly with sulph dioxide solutions containing less than 10% SO_2 and temperatures above 100°C.

Ordinarily, the bisulphite is of a calcium base, though in certain special cases magnesium, sodium, a ammonia-base liquors have been used for this purpos Reuse of the inorganic content of the spent liquor f successive pulping of new wood batches requires special recovery system since furnace ash or smelt th results on burning of the evaporated liquor must be o composition that lends itself to a practical reconversi to a bisulphite. One such recovery system is current in operation with a magnesium-base cook liquor. Wi sodium-base acid a reducing type of furnace would advantageous if means were provided for separation sulphide from carbonate and with subsequent conv sion of the carbonate to sulphite. In such a syste provision can be made for a conversion of sulphide sulphite, or for means of using the separated sulphide an adjoining kraft pulp operation. Such recovery pr esses have been engineered but have not been put in actual use in this country.

In U. S. pat. 1,427,125 the author disclosed a pulpi procedure that depends on the digestion of wood liquors that contain free sulphur dioxide and solul sulphates. It was shown that a satisfactory substi tion of the sulphate for the sulphite can be accomplish without resorting to abnormally high percentages free sulphur dioxide and with cooking pressures a time periods not far different than those ordinarily e

George A. Richter, Eastman Kodak Co., Rochester, N. Y.

Table I. Influence of Temperature

In all cases western hemlock laboratory chips (3/4 in. long and 1/8 in. thick) were used. Chips contained about 40% water. Digestions were carried out at maximum gage pressure 100 p.s.i. Maximum temperature was reached in 4 hr. and held there 4 hr. Liquor-chip ratio = 6:1. Lignin content of original wood was 28.8%. In all cases sodium base was used in preparing the bisulphite liquor.

	8% free SO_2 alone		*8% free SO_2, 4% Na_2SO_4*				*8% free SO_2, 0.25% combined SO_2*				*8% free SO_2, 0.5% combined SO_2*				*8% free SO_2, 1% combined SO_2*			
Max. temp., °C.	125	130	125	130	135	140	125	130	135	140	125	130	135	140	125	130	135	140
Relief temp., °C.	112	115	120	119	120	122	114	114	120	116	116	121	116	121	121	121	122	124
Yield, %[b]	54.4[a]	55.4[a]	48.3	46.4	44.7	41.5	44.6	45.8	38.4	35.9	46.8	44.5	40.0	37.9	51.2	48.8	46.1	44.6
Screenings, %	Not screened		0.8	0.3	0.3	0.1	3.2	1.5	12.4	19.1	1.0	1.1	0.5	0.2	1.8	0.3	0.8	0.5
Pentosans, %	..	..	3.7	3.6	3.2	2.8	2.6	1.9	1.5	1.0	3.3	3.1	2.4	1.5	3.9	3.8	3.5	3.5
K number	..	..	17.4	12.9	7.3	4.6	23	25	32	35	8.8	7.8	7.0	5.8	28	10.5	6.7	5.3
Lignin, %	25.0	28.8	..	2 1	1 4	1.2	4.2	..	..	8.3	1.6	..	..	1.4	4.6	..	..	1.3
							Dark brown pulps											

[a] Dark brown, woody products.
[b] Yield is expressed as per cent recovered screened fiber based on wood except in the case where screening is omitted when total yield is figured based on wood. Screenings are expressed as per cent based on weight of screened fiber.
Relief temperature is that at which relief is started to avoid exceeding maximum pressure specified.

ved in orthodox bisulphite pulping. It was also re- led that the quality of resulting pulp is equal to that ainable with bisulphite liquors and that a sulphate- taining cook liquor offers a simpler means for chem- recovery than is possible in the case of the pre- ing sulphite cook procedure.

Much experimentation has taken place since the ly disclosure, and work has been extended to include er buffer materials than sodium sulphate. Results of ne phases of this investigation are given below. rking theories to explain the process are offered.

Although it has been demonstrated that 1200-lb. od chip batches can be processed successfully by the isclosed procedure, the experimental results here cited ere obtained from digestions of laboratory-prepared ood chips in rocking digesters that were electrically eated and provided with means for relieving gas, thus llowing opportunity to follow selected conditions of ressure and temperature. For the most part western emlock was used. Enough figures are included to now that northeastern spruce responds in similar fash- n. Products were characterized by yield, screenings, d chemical tests. Although this article includes no uch data, many of the raw stocks were converted to terification grade pulps of good quality. In cases here the product was not substantially pulped, screen- ng was omitted and the total yield determined. In me instances pulps were compared in respect to K umber. In other cases lignin comparisons were made, d for some purposes pentosan figures are included.

The total investigation covered a large number of xploratory cooks and had as its main purpose the es- blishment of optimum operating conditions for pulp- ing with the sulphate-containing liquors. A few comparison cooks were made with sulphurous acid alone and several examples are given to show corresponding results obtainable with bisulphite solutions applied in the orthodox manner. Variables studied included: concentration of free sulphur dioxide, per cent sulphates or other salts in liquor, maximum temperature of cook, digestion time, and maximum pressure of cook.

Table I comprises cooks made with five types of liquor and at maximum temperatures ranging from 125 to 140°C. With the prescribed maximum temperatures, the digestions made with sulphur dioxide solution in the absence of buffer salt yielded an unpulped woody product with high lignin content. The figures show that not more than about one half of the original wood lignin was removed. Most of the remaining lignin can probably be explained by loss of reactivity in the early stages of the cook.

Substantial delignification occurred in all cases where sodium sulphate was used. Degree of pulping improved with increased temperature, but yield was disproportionately lowered when temperatures exceeded 135°C. For the most part, yields compared favorably with the pulps of corresponding K numbers obtained with the bisulphite liquors.

The digestions made with liquor that contained a low percentage of combined sulphite show the characteristic combination of low yield, high screenings, poor bleachability, and low pentosan content when the maximum temperature exceeds 130°C. At the lower maximum temperatures, the time period chosen allowed substan-

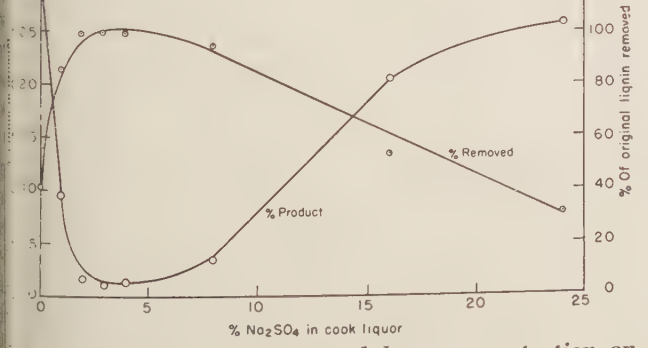

Fig. 1. Influence of sodium sulphate concentration on lignin removal (see Table II)

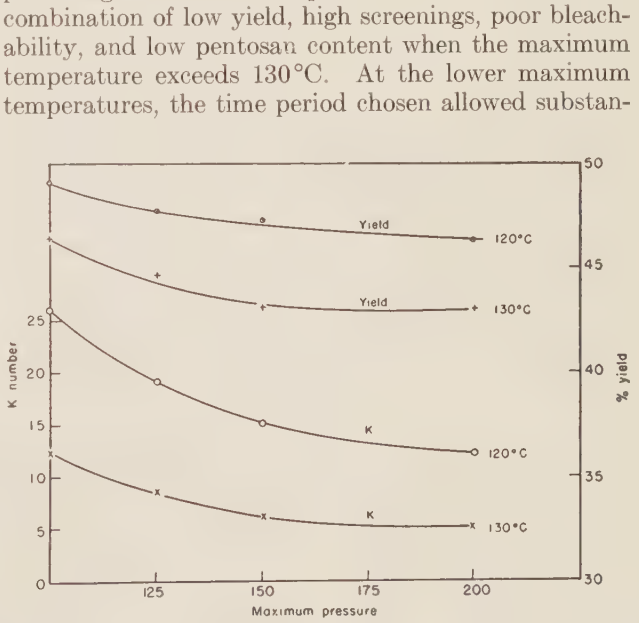

Fig. 2. Influence of maximum cook pressure on yield and K number (see Table IV)

Table II. Influence of Na_2SO_4 Concentration

Western hemlock wood chips used as in Table I. Cooking conditions as in Table I except as otherwise noted.

Free SO_2, %	8	8	8	8	8	8	8	8	0
Na_2SO_4, %	0	1	2	3	4	8	16	24[a]	24
Max. temp., °C.	130	130	130	130	130	130	130	130	130
Relief temp., °C.	120	116	120	119	118	123	126	127	..
Actual max. press. obtained	100	100	100	100	100	100	100	100	100[b]
Yield, %	58.3	45.4	42.5	43.0	45.6	47.9	62.8	76.8	93
Screenings, %	n.s.	1.0	1.2	1.3	0.6	3.5	n.s.	n.s.	n.s.
K number	..	..	8.7	8.6	10.9	18.1	..	..	..
Lignin, %	29.6	9.5	1.5	1.0	1.2	3.2	21.4	25.7	31.3
Combined sulfur, %	0.75	..	..	..	..	..	..	1.5	0.04
pH of cook liquor	1.1	1.1	..	..	1.15	..	1.17	..	6.7
Original lignin removed, %	40	85	98	99	98	95	54	32	0
Original nonlignin removed, %	43	42	42	40	37	36	31	20	11.5

[a] This product was well washed and redigested in 15% free SO_2. A temperature of 110°C. (150 lb. maximum gage pressure) was reached in 1 hr., and this temperature was maintained 7.5 hr. Excellent pulping took place with an over-all yield of 36.2% based on wood. Lignin content of this pulp was 0.31%.
[b] Nitrogen pressure was used.
n.s. signifies that the product was not screened.

tially complete pulping, although the resulting pulps show high lignin and poor bleachability.

Higher percentages of combined sulphur dioxide in the liquor were accompanied by good pulping, and test figures show the well-known need of higher maximum temperatures as the combined sulphur dioxide is raised from 0.5 to 1%.

Just as experienced with combined sulphur dioxide percentages present in orthodox acid sulphite pulping, the concentration of soluble sulphate plays an important role in determining the ease of lignin removal. Also, as

Table III. Influence of Na_2SO_3 Concentration

Western hemlock wood chips used as in Table I. Cooking conditions as in Table I except as otherwise noted.

Free SO_2, %	8	8	8	8	8	15
Na_2SO_3, %	..	1	2	4	16	16
Max. temp., °C.	130	130	130	130	130	130
Relief temp., °C.	..	120	121	125	None	128
Actual max. press. obtained	100	100	100	100	22	100
Yield, %	58.3	44.5	46.8	49.6	87	49
Screenings, %	n.s.	1.1	0.3	1.0	n.s.	n.s.
K number	..	6.8	10.5	17	..	..
Lignin, %	29.6	1.1	1.4	2.2	26	2.8
Combined sulfur, %	0.75	..	..	..	..	..
pH of cook liquor	1.1	1.2	1.3	1.5	3.0	1.7
Original lignin removed, %	40	98.3	97.7	96.2	21.5	95.3
Original nonlignin removed, %	43	38	35	32	10	33

with bisulphite, reductions in concentration of the sulphate must be accompanied by reductions in maximum temperature and extension in time to obtain pulps of fair to good quality. With concentrations substantially above 4%, higher temperatures are needed for good pulping, and when the sulphate concentrations are raised to above 12%, only partial delignification occurs. With such high concentrations of sulphate, the behavior of the liquors resembles that of the acid sulphite solutions in which the combined SO_2 equals or exceeds the free.

Table II and Fig. 1 show this important influence o salt concentration. In this series the sodium sulphat was progressively increased to an upper limit of 24% At the maximum digestion temperature in questio (130°C.), an optimum combination of yield and bleach ability was reached at a salt concentration of between 3 and 4%. Those figures approximate the results obtain able with a 2% sodium sulphite-containing liquo (roughly 1% combined sulphur dioxide). Calculation showing the per cent of the original nonlignin constitu ents removed are of interest. The figures show tha there is a substantial portion of the original lignin tha is readily solubilized even though no pulping take place and that the removal is accompanied by an ap proximately equal percentage elimination of nonligni components originally present. This suggests the pres ence in the wood of certain amounts of easily solubil ized lignin and cellulose and that the solubilization o the lignin takes place before it is rendered inactive b the acid at the higher temperatures or that it occurs be cause it is less susceptible to deactivation than the re maining portions. The digestions made with the 1 and 24% sulphate liquors indicate a lesser attack on th cellulose as witnessed by the fact that in these case the removal of lignin is approximately as great a with the 8% free SO_2 solution, but cellulose is lost i lesser amount.

The high concentrations of sulphate interfere with fu removal of lignin but do not deactivate it permanently This was demonstrated in the case of the produc prepared with the cooking liquor that was made to con tain 8% free SO_2 and 24% sulphate. The product wa wholly unpulped. It was thoroughly washed to an as content of 0.1%. The yield was 76.8% and the ligni over 25%. Analysis showed a combined sulphur con tent of 1.5%, equivalent to about 6% based on lignin The sulphonated wood responded readily to a secon digestion with a 15% sulphur dioxide solution to yield very low lignin pulp in much the same manner as can b done with sulphonated but unpulped product that prepared with a first stage sodium sulphite digestion.

Table IV. Influence of Increased Cooking Pressure

Western hemlock laboratory chips used. In all cases liquor-chip ratio = 6:1. Cooking liquor contained 15% free SO_2 and 4% Na_2SO Time of cook in all cases = 4 + 4 hr.

Max. temp., °C.	130	130	130	130	120	120	120	120
Max. press., lb.	100	125	150	200	100	125	150	200
Relief temp., °C.	84	92	105	121	84	95	106	None
Yield, %	46.4	44.6	43.1	43	49.0	47.7	47.3	46.3
Screenings, %	0.4	0.2	0.7	0.1	5.5	2.3	1.0	0.2
Pentosans, %	3.3	3.2	3.2	3.2	3.9	3.7	3.7	3.6
K number	12.2	8.6	6.0	5.2	26	19	15	12

Table V. Influence of Increased Percentage of Free SO_2 in Cook Liquor

Western hemlock laboratory chips used. In all cases liquor-chip ratio = 6:1. Time of cook in all cases = 4 + 4 hr.

Free SO_2, %	5	8	10	15
Na_2SO_4, %	4	4	4	4
Max. temp., °C.	130	130	130	130
Max. press., lb.	80	100	100	100
Relief temp., °C.	None	118	103	80
Yield, %	49.6	47.5	47.0	46.2
Screenings, %	3.5	0.7	Trace	Trace
K number	26.5	13.9	11.3	10.5

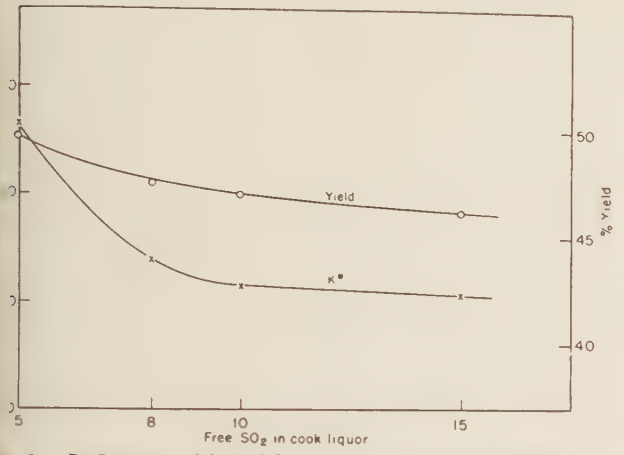

Fig. 3. Influence of free SO_2 concentration on yield and K number (see Table V)

Table VI. Digestions Made with Liquor Containing Both Sulphite and Sulphate

Hemlock laboratory chips used. Liquor-chip ratio = 6:1. Cooking time in all cases = 4 + 4 hr.

Free SO_2, %	8	8	8	8	8
Na_2SO_3, %	1	0.6	1	0	0
Na_2SO_4, %	2	2	0	2	0
$MgSO_3$, %	0	0	0	1	1
$MgSO_4$, %	0	0	2	0	2
Max. temp., °C.	135	135	135	135	135
Max. press., lb.	100	100	100	100	100
Yield, %	44.1	45.2	44.3	45.0	45.1
Screenings, %	0.1	0.7	0.4	0.2	1.0
K number	6.4	7.5	7.3	8.7	9.4

sulphate in the sulphurous acid solution allows sulphonation to take place beyond a point attained by sulphur dioxide alone and does serve as a protection for the unsulphonated or the sulphonated lignin, or possibly both, thus preventing deactivation of lignin by the sulphurous acid in the early stages of the digestion. Whether this protection is given by the sodium sulphate itself or by a progressively formed sodium bisulphite is discussed in connection with other experiments that follow.

Table III includes comparison cooks made with increasing percentages of sodium sulphite in the pulping liquor. The results show the same influence of high salt concentration as found with the sulphates in Table II.

Table VII. Digestions Made with Laboratory Chips of Northeastern Spruce and Yellow Birch Origin and with Liquors Containing Sulphurous Acid and Sodium Sulphate

Liquor-wood ratio = 6:1. Maximum temperature = 130°C. Cooking time = 4 + 4 hr. Maximum pressure = 100 lb. Lignin in original spruce wood = 29.8%. Lignin in original yellow birch = 28.2%.

Free SO_2, %	5[a]	5	5	5	5	5	5	8	8[b]
Na_2SO_4, %	0	3	4	8	15	25	0	4	4
Na_2SO_3, %	0	0	0	0	0	0	2	0	0
Yield, %	56.2	45.8	45.7	48.8	43.5	No	46.6	44.1	45.2
Screenings, %	..	1.4	2.9	7.8	18.5	Pulp	1.1	1.1	1.4
Lignin, %	29.0	2.2	3.8	5.6	16.0	24	1.9	1.8	2.0

[a] Product not screened.
[b] Yellow birch.

A corresponding experiment made with a neutral 4% sodium sulphate solution in the first stage of a two-step sequence showed no pulping and only 0.04% combined sulphur in the washed intermediate product. When it was redigested in the 15% sulphurous acid liquor, no pulping took place. Lignin content of that final product was 22%. In another case not shown in the table, the wood chips were digested first in an 8% sulphur dioxide solution at 130°C., then thoroughly washed and redigested in fresh 15% sulphurous acid in the same manner as cited in the preceding experiments. The washed intermediate product contained 0.75% combined sulphur (about 3% sulphur based on lignin), but no pulping took place in the second stage. The final product tested 25% lignin. All of the above supports the viewpoint that the presence of the 24% sodium

Here again, there is the same evidence of less loss of cellulose than lignin as found with the sulphates in those cases where high salt concentration is adopted. One case in Table III illustrates the marked improvement in delignification when high salt concentration is accompanied by fortification of free SO_2 to a point well above that which corresponds to the bisulphite.

With relatively low maximum temperatures, higher maximum pressure maintained in pulping is effective in causing more complete delignification as evidenced in Table IV and in Fig. 2. In this series a 15% free SO_2 level was prescribed to enable the operator to reach the higher pressures. Sodium sulphate was held at 4% throughout this series. Sacrifice in yield with increased pressure was only slight, particularly when a 120°C. maximum temperature was held.

Table VIII. Digestion of Wood with Sulphurous Acid Containing Various Sulphates

Western hemlock laboratory chips used. In all cases salt concentration was 4%. Liquor-wood ratio = 6:1. Digestion time = 4 + 4 hrs. Maximum temperature = 130°C. Maximum pressure = 100 lb. gage.

Free SO_2, %	8	8	8	8	8	8	8	8	8
Salt used	None	Na_2SO_4	K_2SO_4	$(NH_4)_2SO_4$	Li_2SO_4	Na_2SO_3	$ZnSO_4$	$MgSO_4$	$Al_2(SO_4)_3$
Relief temp., °C.	112	118	121	121	115	100	117	118	113
Yield, %	58.0	45.6	43.1	46.4	47.6	47.4	40.5	41.3	63.8
Screenings, %	n.s.	0.6	1.0	0.3	2.5	n.s.	9.8	13.9	n.s.
K number	..	10.9	10.0	11.5	14.2	0	14.8	14.6	..
Lignin, %	30.6	1.2	1.4	2.1	2.9	16.5	2.9	3.2	18

Table IX. Influence of Cooking Pressure and of High Free SO_2 Concentration on Pulping with Magnesium Sulphate Liquors

Western hemlock laboratory chips used. Liquor-wood ratio = 6:1.

Free SO_2, %.....	8	10	15	15	8
Max. temp., °C.....	130	130	130	120	130
$MgSO_4$, %.....	4	4	4	4	4
Relief temp., °C.....	118	103	81	104	None
Max. press., lb.....	100	100	100	150	125
Yield, %.....	41.3	43.0	45.9	44.3	45.9
Screenings, %.....	13.9	2.7	0.4	0.6	0.2
K number.....	14.6	13.6	11.0	8.9	12.0
Lignin, %.....	3.2	2.7	1.7	1.4	2.6

Just as with the bisulphite pulping process, distinct advantages are gained with the sodium sulphate-containing liquor when the free SO_2 concentration is raised to higher levels. Table V demonstrates the degree of improvement possible as the SO_2 is increased from 5 to 15%.

Soluble sulphates can be used in combination with bisulphites of metals that form soluble sulphates. Examples of pulpings made with such liquors are shown in Table VI. This has practical significance since it offers a choice of a soluble sulphate or a sulphite-forming base as make-up material for losses experienced in the recovery cycle. Thus, the added chemical can be sodium carbonate, magnesium carbonate, ammonia, etc., as well as the corresponding sulphates. Yields and bleachability of pulps shown in Table VI are quite normal.

Northeastern spruce and birch respond readily to delignification when digested with sulphurous acid solutions of sodium sulphate in much the same manner as does western hemlock. Table VII summarizes a few trials made. The effect of increasing percentages of salt in solution parallels that obtained with the hemlock. The lower lignin found with the higher sulphurous acid concentrations is interesting but not unexpected. Table VII includes a comparison cook in which both sulphite and sulphate were omitted. As with hemlock wood pulping did not occur.

Substitution of other soluble sulphates for the sodium salt showed that when the maximum temperature was maintained at 130°C., the potassium, lithium, and ammonium salts are about equivalent to the sodium base (see Table VIII). The zinc and magnesium sulphates behave in like fashion although pulps so prepared have more screenings unless cooking conditions are modified to favor a more complete penetration of wood by the salt before severe deactivation of lignin takes place by the free SO_2 at the higher temperature. This can be accomplished by increasing the free SO_2 in the cook liquor, or by increasing the pressure and thus increasing the free SO_2 concentration during most of the cook period, or by reducing the maximum temperature and extending the digestion.

The poor performance of the aluminum sulphate is explained by the higher free sulphuric acid formed. Although not shown in Table VIII, it was demonstrated that when the liquor-chip ratio was raised to 10:1 and when cooking was carried out in the absence of metal and at a lower maximum temperature (120°C.), pulps containing as low as 5% lignin were produced. Further evidence that more suitable conditions can be found for pulping with aluminum sulphate liquor appears in Table X, which lists a cook made with matchlike wood units and in the absence of metal.

Table XI. pH Readings of Various Solutions

Salt	*pH*	*% free SO_2 by titration*	*% combined SO_2 by titration*
None	1.1	8	0
2% Na_2SO_3	1.35	5.7	1.0
4% Na_2SO_3	1.60	5.7	1.97
8% Na_2SO_3	2.10	5.7	3.96
16% Na_2SO_3	3.2	8.16	8.06
22% Na_2SO_3	5.4	8.15	11.4
1% Na_2SO_4	1.1	8.0	..
4% Na_2SO_4	1.15	8.0	..
8% Na_2SO_4	1.17	8.1	..
16% Na_2SO_4	1.17	7.9	..
24% Na_2SO_4	1.18	5.0	..
4% $ZnSO_4$	0.62	5.2	−0.03
8% $ZnSO_4$	0.62	5.0	−0.04
4% $MgSO_4$	0.62	4.9	−0.05
8% $MgSO_4$	0.62	4.5	−0.03

The negative combined SO_2 values for the four last cases are actual figures as determined by volumetric analysis.

In the case of magnesium sulphate liquors, the influences of higher percentages of free sulphur dioxide and of higher maximum pressures are seen in Table IX. A particularly favorable result was obtained with a set of conditions calling for 15% free SO_2, a low maximum temperature and high maximum pressure.

Use of less common sulphates such as cadmium, cobalt and nickel were included to further demonstrate the principle of sulphate liquor pulping (see Table X). Such experiments were carried out in the absence of metal in glass flasks that were heated to the prescribed temperature supported within a digester where a balanced pressure could be applied. In these trials a maximum temperature of 120°C. was held for an 8-hr. time period. All soluble sulphates yielded well-pulped products. The relatively insoluble sulphates of calcium, strontium, and barium show progressively poorer delignification, the loss in pulping effectiveness being roughly proportioned to the solubility of those respective salts in water. In all three cases substantial amounts of undissolved salt remained present in the spent liquors.

There is no complete explanation for the behavior of the sulphates in the sulphurous acid cooking solutions. One can postulate that the salt reacts with the free SO_2 to form bisulphite and bisulphate and that this reaction progresses as the sulphite is consumed in the pulping. The degree to which this occurs in the original liquor must be slight since the usual titration methods reveal no combined SO_2. Whether the conversion takes place

Table X. Use of Other Sulphates Than Those Listed in Table VIII

These cooks were made in glass using western hemlock in the form of match-size units. Maximum temperature = 120°C. (2 + 8 hr.). Maximum pressure approximates 120 lb. No gas relief practiced. All products not screened.

Free SO_2, %.....	8	8	8	8	8	8	8	8	8	8	8
Salt used.....	None	$CdSO_4$	$CaSO_4$[a]	$SnSO_4$[a]	$BaSO_4$[a]	$Al_2(SO_4)_3$	$NiSO_4$	$FeSO_4$	$MnSO_4$	$CoSO_4$	Na_2SO_4
Salt, %.....	None	4	4	4	4	4	4	4	4	4	4
Yield, %.....	51.0	47.7	46.5	50.5	49.5	48.2	48.9	49.1	49.4	49.1	47.7
Lignin, %.....	17.0	0.9	5.6	11.8	12.1	2.6	1.8	0.7	1.5	0.8	1.4

[a] In these cases the acid liquors contained the undissolved salt.

Table XII. Addition of Bisulphate to Sodium Sulphate Liquors

Western hemlock laboratory chips used. Liquor-chip ratio = 6:1.

ree SO_2, %	10	10	10	10	10	10	15	15	15
Na_2SO_4, %	0	2	4	0	0	2	0	2	0
$NaHSO_4$, %	0	0	0	2	4	2	0	0	2
ax. temp., °C	130	130	130	130	130	130	110	110	110
ax. press., lb.	100	100	100	100	100	100	150	150	150
ief temp., °C	102	104	104	99	100	100	..	..	..
ne, hr.	4 + 4	4 + 4	4 + 4	4 + 4	4 + 4	4 + 4	1 + 7.5	1 + 7.5	1 + 7.5
eld, %	51.3	43.8	45.5	48.8	47.4	43.8	52.9	50.2	50.5
reenings, %	n.s.	0.3	0.4	n.s.	n.s.	0.5	n.s.	n.s.	n.s.
number	..	10.0	9.4	..	..	9.8	..	..	..
gnin, %	20.0	1.2	1.2	17.6	16.5	..	11.0	5.4	9.8

re easily at the elevated temperature of the cook is known. Cooking acids made up to contain free and increasing amounts of sodium sulphate do not w the progressive increase in pH as found when so- m sulphite is added. Figures appearing in Table

le XIII. Influence of Added Sulphuric Acid to Sodium Sulphate Cooking Liquor

oratory chips of western hemlock origin used. Liquor-wood = 6:1. Digestion time = 4 + 4 hr. Maximum tempera- ture = 130°C. Maximum pressure = 100 lb. gage.

SO_2, %	8	8	8	8	8
SO_4, %	4	4	4	4	4
$_4$, %	0	0.276	0.69	1.38	2.07
f temp., °C	118	115	117	118	126
d, %	45.3	44.9	45.0	45.2	64.3
	All products unscreened				
gnin, %	2.6	3.0	2.8	5.3	21.7

he H_2SO_4 was added to a calculated conversion of Na_2SO_4 to $aHSO_4$ as follows:

0%	10%	25%	50%	75%

I are typical. All solutions containing the sulphates ave substantially the same pH as the sulphurous acid self. This is as one would expect since any bisulphite rmed is offset by bisulphate which itself has a pH vel of about 0.6. The low pH's of the sulphate liquors lp explain the better results when such pulpings are

the degree of delignification that is possible with sulphurous acid alone. Also, in limited amounts, it has no appreciable deleterious influence when added to a liquor that has been prepared with sodium sulphate and when pulpings are carried out with maximum temperature at 130°C. The increasing percentages of lignin in the products made with the liquors in which larger amounts of sodium sulphate were converted to sodium bisulphate by addition of sulphuric acid are as one would expect.

In the case of liquors made up to contain no salt, delignification is seriously interfered with when free sulphuric acid is added to the sulphurous solution (see Table XIV). The addition of phosphoric acid is less harmful, but on the other hand, small percentages of hydrochloric are particularly injurious.

All of the above supports the conception that cations supplied by buffer salt present in this type of liquor are instrumental in lessening the injurious effects of lignin deactivation by the free sulphonic acid groups that are formed as digestion proceeds. The degree to which the free sulphonic acid groups are neutralized by the metal of the buffer salt depends upon the presence or absence of other strong acid groups such as hydrochloric or sulphuric. Higher percentages of bisulphate behave similarly in preventing some neutralization of the free sulphonic acid.

Table XIV. Influence of Second Acid in Sulphurous Acid Pulpings

Digestions made with western hemlock laboratory chips. Liquor-wood ratio = 6:1.

ee SO_2, %	15	15	15	15	15	15	15
a_2SO_4, %	0	0	0	0	0	0	0
$aHSO_4$, %	0	0	0	0	2	0	0
SO_4, %	0	0.25	1	2	0	0	0
iscellaneous chemical	..	..	..	..	..	1% H_3PO_4	0.25% HCl
ax. temp., °C	110	110	110	110	110	110	110
x. press., lb.	150	150	150	150	150	150	150
ne, hr.	1 + 7.5	1 + 7.5	1 + 7.5	1 + 7.5	1 + 7.5	1 + 7.5	1 + 7.5
ief temp., °C	102	101	103	102	103	101	101
eld, %	52.9	55.9	59.2	64.4	50.5	52.6	56.3
				All products unscreened			
number	..	..	..	..	..	..	..
gnin, %	11.2	13.8	21.9	29.4	9.8	12.6	17.4

ade at temperatures in the neighborhood of 130°C. In order to understand more fully the influence of dium bisulphate that forms in the sulphate-base cook quor, a series of digestions was made with deliberate dition of sodium bisulphate to salt-free sulphurous id and to sulphate-type liquors (see Table XII). ditional cooks were made in which free sulphuric id was added in increasing amounts to the sulphate- pe liquor, thereby converting portions of the original lphate to bisulphate (see Table XIII).

The results show that under normal cooking condi- ons the bisulphate is practically ineffective in altering

Low maximum cook temperatures lessen the deactivating influence of the free sulphonic and other free strong mineral acids that may be present. If, as appears likely, the sulphate salt liquors contain only small amounts of the bisulphate, it probably has no appreciable influence except under conditions where the maximum temperature exceeds 135 to 140°C. A mixed sulphate-sulphite acid allows some greater leeway since the presence of the bisulphite gives some further protection.

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The Lever Spore Cloud Method for the Evaluation of Antimycotic Properties of Paper and Paperboard Used in the Soap Industry

L. J. VINSON

A simple and convenient assay method is presented for measuring the degree of resistance of antimycotic-treated paper and paperboard toward soap spoilage organisms. A spore cloud inoculum is described comprising the test molds grown on wheat bran to yield a highly sporulated mold bran preparation which remains stable in a dry state for long periods of time. Antimycotic data with the Lever spore cloud method correlates well with accelerated storage results on soap wrapped in moldproofed paper.

REGULAR wrapped soap stored in cases under warehouse conditions is susceptible to mold spoilage. The extent of mold development and the time of its appearance are influenced to a large degree by storage conditions. For example, mold spots can be readily detected on untreated soap wrappers and the soap itself after only 2 months' storage at a temperature of about 90°F. and high relative humidity.

Adequate protection against molds of soap-wrapping material is desirable since soap under practical conditions may be stored in warehouses for 3 months or more. Protection can best be accomplished by the incorporation of an effective antimycotic into the paper and paperboard.

In the consideration of this problem, it became apparent that a simple and convenient assay method was needed which would serve two needs: (1) measuring the potency of antimycotics for use in paper, and (2) routine checking of the mold-resistant properties of treated soap-wrapping material.

Several practical methods have been developed in recent years for determining the resistance of paper and paperboard to cellulose-attacking fungi. In Shema's (*1*) method, the test organisms, *Chaetomium globosum* and *Aspergillus niger*, are used in evaluating paper samples on a mineral salts agar medium. Evidence of mold growth on the paper serving as the sole source of nutrient carbon is indication of poor or no antimycotic resistance.

Cruickshank (*2*) prefers the use of a dextrose agar medium (Sabouraud's medium) for assaying antimycotic-treated paper. Still another method which has received considerable attention is the Bulab method of Appling and co-workers (*3*) assessing the antifungal activity of paper in an environment of mineral salts solutions eliminating the use of agar entirely.

The Lever spore cloud method to be described combines several of the features of these methods and also makes use of a different type of inoculum for the evaluation of soap-wrapping material treated with antimycotics.

LEVER SPORE CLOUD METHOD

Soap Spoilage Organisms

Three molds found predominating on wrapping material and soap showing mold spoilage were isolated and identified* as: *Aspergillus sydowi*, *Aspergillus versicolor*, and *Penicillium chrysogenum*. A fourth, found occasionally on moldy paper, was identified as *Aspergillus niger*. Only the first three named, however, were utilized as test organisms being maintained as stock cultures on Czapek agar containing 3% sucrose

Modified Czapek Agar Medium

In the actual assay, the Czapek agar medium is modified to contain 0.5% sucrose which serves to initiate the growth of molds which then become dependent upon the paper to sustain and extend its growth. The presence of an effective toxicant in the paper, of course, prevents the utilization of the latter as a source of food. The modified Czapek agar contains KH_2PO_4 in place of the dibasic phosphate with the pH of the medium adjusted to 5. This was found necessary since several of the antimycotics tested were soluble at neutral or alkaline pH and diffused into the agar. The weight composition of the modified Czapek agar used in the Lever spore cloud method is as follows:

$NaNO_3$	3.0 grams
KH_2PO_4	1.0 grams
$MgSO_4$	0.5 grams
KCl	0.5 grams
$FeSO_4$	0.01 grams
Agar	15.0 grams
Sucrose	5.0 grams
Water	950.0 grams

The assay medium is prepared by dissolving the agar in water, applying heat; the salts are then added, followed by the sucrose. After adjusting the pH to 5 with HCl, the agar medium is sterilized for 20 min. at 15-lb. steam pressure.

Fifteen-milliliter quantities are poured into Petri plates and permitted to harden.

Preparation of Spore Cloud Inoculum

The inoculum consists of a dried, highly sporulated preparation of the molds grown on wheat bran. The method of preparation is as follows:

Ten-gram quantities of wheat bran in 250-m

L. J. VINSON, Section Chief of the Biochemical Section, Lever Brothers Co., 45 River Road, Edgewater, N. J.

* We are grateful to Kenneth B. Raper of the Northern Regional Research Laboratory who assisted in the identification of the molds.

Fig. 1. Inoculation of paper samples using the spore cloud inoculum conducted in a special plastic chamber to avoid spreading of contamination

Erlenmeyer flasks are mixed with equal weights of water. The flasks are plugged with cotton and autoclaved for 20 min. at 15-lb. steam pressure. The wheat bran upon cooling is inoculated with either a previously prepared mold bran (2 grams) or with an aqueous suspension (2 ml.) of the soap spoilage organism maintained on Czapek agar slants.

The thoroughly mixed bran is then incubated at room temperature with the flasks set on their sides to expose maximum surface. Within 48 hr. the mold has grown extensively throughout the bran mass with sporulation ensuing as the mold bran begins to dry out.

This phase can be hastened by breaking up the solid moldy mat with a spatula and transferring to Mason jars. Thoroughly dried, the mold bran takes on a powdery appearance and is in a highly sporulated state.

Each of the three soap spoilage organisms is grown separately on wheat bran, and the mold brans are then combined to form the inoculum used in the spore cloud assay. The dried mold bran remains stable and viable indefinitely; and for our purposes, a batch as small as 25 grams has served as an inoculum over extended periods.

Assay Procedure

Four 1-in. squares are cut from a paper sample† under test and are placed on a Petri plate containing the hardened agar; two squares have one side up and the other two have the reverse face exposed. Prior to placing on the modified Czapek agar surface, the squares are inoculated with the prepared mold bran inoculum. This is effected by inserting the squares for a moment into the head space of the Mason jars containing the well-sporulated mold bran mixture which is agitated gently to create a cloud of spores.

Inoculation and positioning of the paper squares on the plates are conducted in a specially built transparent chamber constructed of Lucite plastic having the dimensions 24 by 15 in., and 15 in. high. Two circular openings (4 in. diameter) to conduct the operations are present, as shown in Fig. 1.

† In case of paperboard, the three layers are separated into outer, inner, and corrugated liners which are tested separately.

This precaution is taken to avoid possible contamination of the room or laboratory with mold spores and has proved very effective.

After inoculation of the paper squares, the plates are incubated at room temperature and are examined after 7, 14, and 21 days for mold development. The following convenient antimycotic ratings are used to indicate extent of mold growth (Fig. 2).

0	No growth
1	Few small foci of growth
2	Moderate number of mold spots
3	Thin over-all growth
4	Heavy over-all growth

The antimycotic score of the test paper can then be expressed as a three-digit value, indicating mold development after 1, 2, and 3 weeks. Some examples of antimycotic ratings and their significance are given below:

000 or 011—Excellent or very good protection
112 or 123—Good or fair protection
234 or 344—Poor or very poor protection

Untreated paper under conditions of the test show heavy over-all growth or a value of 4 within 2 to 3 days.

DISCUSSION AND CONCLUSION

The Lever spore cloud method has proved to be a very convenient and reliable means of evaluating the moldproofing properties of antimycotic-treated paper and paperboard. The advantages of this method, particularly from the standpoint of assessing the antifungal potency of treated soap-wrapping material, are as follows:

1. The use of a stable spore cloud inoculum which lasts for months eliminates the need of frequent handling of stock cultures to prepare inocula. Also, uniformity in mold response is assured.

2. The presence of a small amount of sucrose (0.5%) in the agar medium serves the purpose of stimulating the germination of the mold spores. Growth development of the mold occurs only in the absence of an effective toxicant contained in the paper. A strong antimycotic in sufficient concentration can inhibit germination of the mold spores entirely.

3. Treated soap-wrapping material with good to

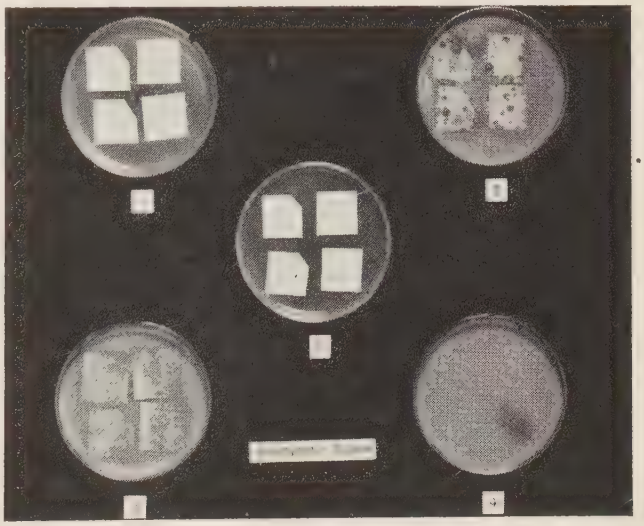

Fig. 2. Degrees of mold growth on paper tested by the Lever spore cloud method

excellent antimycotic properties under conditions of the Lever spore cloud method was shown to give satisfactory protection to soap under accelerated storage conditions during a six-month period.

The importance of protecting paper and paperboard used in the packaging of soap becomes very evident when one considers that the appearance of mold on soap during storage is always associated with and always preceded by the appearance of mold growth on the soap-wrapping material.

The Lever spore cloud method can be adapted to evaluate the antimycotic resistance of paper and paperboard serving other industries involving spoilage organisms different than those described in the foregoing. For example, the organisms associated with paper spoilage—*Chaetomium globosum*, *Aspergillus niger*, *Aspergillus terreus*, and others—can be readily prepared in the form of mold bran to serve as a spore cloud inoculum.

LITERATURD CITED

1. Shema, B. F., *Paper Trade J.* 123, No. 23: 137–138 (1946).
2. Cruickshank, G. A., *Tappi* 32, No. 8: 370–373 (1949).
3. Appling, J. W., Buckman, S. J., and Cash, S. D., *Tappi* 32: 427–429 (1949).

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The Removal of Dirt and Gases from Pulp Stock Suspensions

HORACE FREEMAN and JOHN D. BOADWAY

One of the latest refinements practiced in papermaking is the removal of gas from stock. Gas in stock exists in three states; as bubbles, as gas in solution, and as gas adsorbed on fibers. The gas as bubbles is harmful as it acts to float and flocculate fiber and pitch. To ensure that bubbles are removed and that they have no chance to reform, it is necessary to remove a considerable portion of the total gas. It has been found that by redesign, the Vortrap, used throughout the paper industry as a centrifugal dirt separator, may be applied to remove simultaneously both gases and dirt. This is achieved by increasing the fluid velocity within the separating tube so that a vacuous core is produced to which gases are displaced by centrifugal force and from which they may be removed by a vacuum pump.

The development of the Vortrap* classifier in the Research Division of Consolidated Paper Corp. Ltd. commenced in 1932 and the first paper mill installation was made in 1933, at the Wayagamack mill at Three Rivers, Que.

The removal of dirt from papermaking stock by means of the Vortrap was first publicly described in a paper given to the Technical Section of the Canadian Pulp and Paper Association in January, 1937. The use of this classifier in the pulp and paper, and in a number of other industries, has been followed by variations of the device but in the 15 years which have elapsed a total of 9000 Vortraps have been installed in all industrial countries of the world, the majority being used on pulp fiber to the extent of more than 10 millions of tons annually, and the balance being applied in various processes such as coal washing, removing grit from unfilterable materials such as fruit juices, etc.

One of the merits of conditioning liquid suspensions such as pulp by this means has been the economy of space and equipment accomplished by its use.

This paper describes an extension of the use of the Vortrap to effect a still further economy of space and equipment. This is accomplished by utilizing the forces within the Vortrap, aided by the use of a vacuum pump, to eliminate dissolved, adsorbed, and free gas bubbles from the stock.

It is known that dissolved gases and particularly oxygen have long been extracted from cyanide solutions in the gold mining industry by spraying the cyanide solution into a large tank to which a vacuum is applied. Similar equipment is now being introduced into the paper industry and the extent to which these devices are effective in benefiting the operation of paper machines or improving the product is a matter of current interest to the industry.

Devices of this nature not only are expensive but involve considerable redesign and use of space. However desirable the results obtained from various forms of stock conditioning equipment such as screens, centrifuges, Vortraps, and so on may be, there is a limit to the amount of auxiliary equipment which may be accommodated and operated in the paper mill.

In a paper, presented by one of the authors of this paper, at New York to the Technical Association of the Pulp and Paper Industry in 1938, there was shown a photograph of the operation in a glass Vortrap which discloses the existence of a gaseous core along the axis due to centrifugal effect developed from the energy of the incoming liquid.

It was found in early operation of Vortraps that when a Vortrap, or any similar type of vortex cleaner was operated with an open discharge, two effects were obtained: (1) The amount of dirt rejected was increased but a larger amount, up to 20%, of the total stock was also rejected making secondary and even tertiary cleaning a necessity. (2) A reduced pressure at the open end caused air to be drawn into the ascending column of cleaned stock. The stock was therefore fully aerated and this we now know to be detrimental to papermaking. The application of a vacuum pump to the bottom dis-

Horace Freeman, Technical Director, and John D. Boadway, Research Engineer, Consolidated Paper Corp. Ltd., Three Rivers, Que.

* Vortrap is the trademark of Nichols Engineering & Research Corp. for identifying their vortex-type separator and classifier, and this word is used throughout the text for convenience.

charge (rejects) of the vortex, for the purpose of removing the gas, increased the size of the gas core and decreased the amount of rejects even to the point of no separation.

Investigations were subsequently commenced to determine the factors leading to the formation of this core and of its effect upon the classification of the stock in respect of both dirt and gases.

The successful outcome of this work is not dealt with. The authors believe that the device now developed for this purpose will be considered and found applicable, not only in conditioning pulp stock in the paper industry, but in other industries, such as, in defoaming black liquor in black liquor oxidation processes, in deoxygenating cyanide solutions, and in thickening flotation concentrates in the metallurgical fields, in distillation operations in the oil industry, for removing excess chlorine (and grit) from city water, and deaerating boiler feedwater, so that it is here presented as a new piece of chemical engineering equipment.

GAS IN PAPER STOCK

Consolidated Paper Corp. Ltd. have installed a vacuum deaerator (Deculator) at the PortAlfred Division and there are numerous similar installations in North America which have served to demonstrate the advantages of what we prefer to term gas removal.

One can fairly readily realize that gas could exist in paper stocks in three states; as bubbles, as gas in solution, and as gas adsorbed on the surface of fibers. The standard method for measurement of gas in stock is by displacement which gives a measure of the volume occupied by gas bubbles. It was deemed desirable to study the total gas in stock which required the development of other methods of investigation.

Gas was extracted from stock by spraying it into an evacuated flask, the gas extracted was measured as a change in the absolute pressure in the flask; this gas was then compressed to atmospheric pressure and analyzed by standard volumetric technique. The results of these investigations are shown in Tables I, II, and III.

From the observations given in these tables we may draw some rather interesting conclusions. First, from Table I it appears that the supposition that gas exists in three states is verified. The standard displacement technique gives the gas as bubbles as considerably lower than the gas extracted by vacuum treatment. The added gas content which theoretically should be in solution is incapable of accounting for the additional content observed. The additional amount must be thus adsorbed on the fiber: this is verified by the fact that more gas is extracted from 0.6% headbox stock than from 0.2% white water.

Because the gas extracted consists not only of entrained air but also dissolved and adsorbed gases, one would not expect it to have the same composition as air

Table I. Gas Content of Stock Samples

Source of sample	*Total gas, % by volume*	*Gas as bubbles, % by volume*
Stock from headbox, 100°F.	3.1	0.25
White water, 100°F.	2.0	...
Solubility of air in water at 100°F.	1.5	...

Table II. Analysis of Gases Removed from Stock

Source of sample	*CO_2, %*	*O_2, %*	*Remainder, %*
Stock from headbox	6.5	25.5	68.0
White water	3.6	28.0	68.4
Plant water	1.2	24.5	73.3
Air	0.03	21.0	79.1

and this proves to be the case as shown in Table II. The most striking difference is the higher content of carbon dioxide which appears higher with increased consistency.

We may then associate the major proportion of this gas with the fiber rather than the water. The carbon dioxide would appear to make up about 20% of the gas adsorbed on fibers. Whatever its origin, gas in this adsorbed state will likely be as carbonic acid which, when ionized, will give charge to the surface of fibers. This we may readily see could exert considerable influence upon the colloidal behavior of the fiber in suspension.

In actual practice, this action of the carbon dioxide has yet to be verified. The content of gas as bubbles in stock often causes flotation which brings fiber and pitch to the surface where because of its closer proximity it flocculates. Degasified stock, on the other hand, stays suspended for a longer period and finally sinks. This fact is illustrated in Fig. 1, a photograph of degasified and nondegasified stock after standing for a short period.

In the Deculator, the stock after the Bird screens is sprayed against baffle plates in an evacuated tank, then pumped out of the tank to the headbox. Gases are removed by a form of distillation which removes large volumes of water vapor as evidenced by a drop in temperature of the stock. To perform this distillation an extensive vacuum system is required in order to maintain a pressure sufficiently below the vapor pressure of the stock that the gases are flushed out by large volumes of water vapor.

Fig. 1. A photograph showing how untreated stock (left) rises on standing, while degasified stock (right) stays dispersed

Table III. The Performance of Gas Removal Equipment

Source of sample	Total gas, %	Efficiency of removal, %
Port Alfred No. 4 machine before Deculator	2.7	...
No. 4 machine after Deculator	0.8	70
No. 4 machine white water	2.2	...
No. 3 machine white water	2.0	...
No. 3 machine headbox	3.0	..

Table III shows the gas removal achieved by this equipment as being 70% of the original content thus removing all the initial gas bubbles plus a considerable portion of dissolved and adsorbed gases. It is interesting to note that the gas content of the white water, in the wire pit of the machine with degasified stock, is not lower than that of the adjacent machine operating on the same original stock but without degasification. It appears that the great subdivision and higher turbulence in white water falling from the wire makes it become resaturated with dissolved air.

A full evaluation of benefits to be derived from degasification in such terms as increased machine efficiency, higher machine speed, reduced sulphite, and improved quality is yet to be made. However, the general impression at the time of writing is that decided improvement in machine performance is obtainable by use of degasification.

THE THEORY OF THE VORTRAP DEGASSER

Initial attempts made to utilize the early Vortrap design for gas removal proved unsuccessful. An analysis was then made of the hydraulics of this classifier to see if changes could be made to achieve the desired effect.

As a preliminary to such an analysis it is first necessary to consider velocity conditions within the Vortrap.

Within the tube of the Vortrap due to tangential entry and central exit a vortex is produced.

A general expression for such a vortex would be $vr^n = k$, where v is the tangential velocity at radius r and n and k are constants.

In what is termed a free vortex there is no difference in total energy content in points throughout the vortex, accordingly, since by centrifugal force the central liquid gives rise to increased pressure in the outer liquid, velocity energy at the center is high and pressure energy low while at the outside velocity energy is low and pressure high. n in the vortex equation is $+1$, and the equation becomes $vr = k$. The path of particles entering such a vortex is an equiangular spiral.

If inlet and exit of liquid in a free vortex is suddenly blocked, then due to fluid friction the fast moving central liquid rapidly loses energy until a system of minimum shear is obtained whereby the fluid rotates as a wheel. In this condition of vortex, liquid particles at a great radius travel faster, the value of n becomes -1 or, the equation becomes $v/r = k$ and liquid particles move in circles.

The path of flow in classifiers of the Vortrap type has been known for considerable time. This is shown in Fig. 3; liquid enters tangentially, follows the wall downward in a helical path then spirals inward, reversing its axial direction and moves upward in a helical path inside its former travel. At the bottom, the downward

Fig. 2. A photograph showing the vacuum core produced in a 1½-in. Vortrap equipped with glass tube

stream turns over, that is liquid near the wall comes t the center.

The liquid shear and friction in such a system is ver high so there is little doubt that the inner liquid afte traveling its path is considerably lower in energy cor tent than the outer liquid, and the system is not a fre vortex. We may see that the value of n is betwee the extreme condition discussed previously, $n = +1$ a $n = -1$. For the purpose of considering the hydra lics n was assumed to be 0. The assumed vorte equation was then $v = k$, a condition of constant ta gential velocity at all radii.

Having established conditions of velocity we ma then consider pressure conditions existing within th Vortrap. The swirling liquid is subjected to centri ugal force tending to fling it toward the wall; as result the pressure on the axis of rotation is less tha that on the wall. What we wish to achieve in a Vo trap designed to remove gases is that a vacuum co (to which gas could be displaced) should exist about th axis of rotation. Having assumed the relationship uniform tangential velocity at all radii we may estal lish a relationship for the force acting on a thin cylind of liquid of thickness dr at rotational radius r.

$$f = \frac{2\pi\rho l v^2 dr}{g}$$

Integrating we get an expression for total force on th wall of the tube; as limits we use the liquid dimension the radius of the tube and the gas core, the latter e pressed as the radius less the depth of liquid on th wall.

$$F = \int_{r=R-D}^{r=R} \frac{2\pi\rho l v^2 dr}{g}$$

$$F = \frac{2\pi\rho l D v^2}{g}$$

This force acts on the area of the inside wall and hence may be related to the pressure.

$$F = 2\pi RlP$$

Then

$$P = \frac{\rho v^2 D}{Rg}$$

This may be expressed in terms of hydraulics as

$$hp = \frac{2D}{R} hv$$

where

hp = pressure head
hv = velocity head
l = depth of liquid on the wall
R = radius of the Vortrap tube

From the above equation, if the velocity head exceeds the pressure head then a vacuum core is produced the size of which may be predicted.

Using a Vortrap with a glass tube it was possible to verify that this equation although not precise could fairly closely predict the size of core produced under operating condition. A photograph of such a vacuum core is shown in Fig. 2.

By redesign of a Vortrap to produce a sizable vacuum core it became possible to use the Vortrap for separation of both gas and dirt. The changes made were to keep the inlet pressure and flow the same but alter the design to increase the velocity in the tube at the expense of the pressure. These same changes prove by theory to be desirable for improved dirt separation.

For an analysis of dirt separation we make the same assumption of velocity constant at all radii, an assumption which is partially verified by experimental observation of the size of vacuum core. Particles settle in a viscous medium, according to Stokes law.

$$S = \frac{2gA^2(D_1 - D_2)}{9N} = \text{velocity of settling}$$

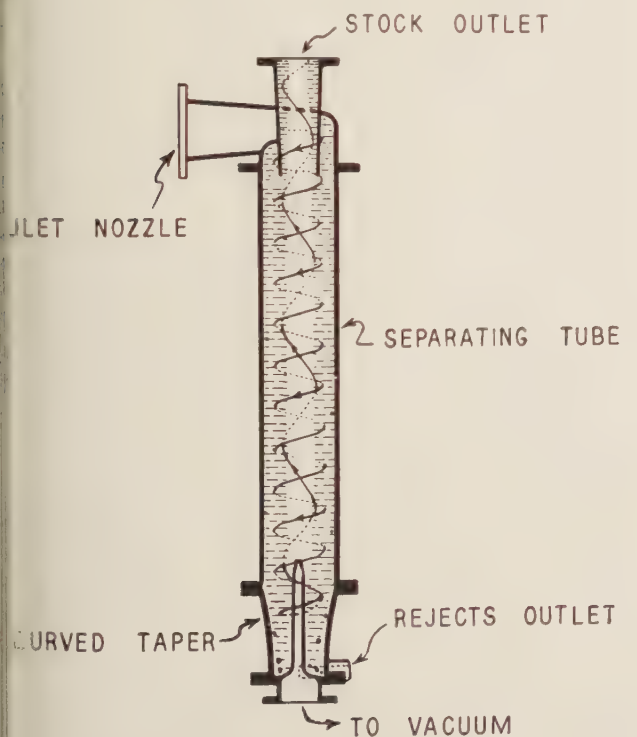


Fig. 3. Cross section of Vortrap degasser showing liquid flow and vacuous core

This simplifies for a given particle of given radius and density in a given liquid to

$$S = gk$$

where
g is the acceleration
S is the settling rate
k is constant characteristic of the particle and medium

Let us consider such a particle at radius r from the center of rotation of liquid in the Vortrap and tangential velocity V; the velocity of settling to the wall by centrifugal force is:

$$\frac{dr}{dt} = k\frac{V^2}{r}$$

or

$$dt = \frac{rdr}{kV^2}$$

The time for such a particle to fall from radius r to the wall will then be:

$$T = \int_r^R \frac{rdr}{kV^2} = \frac{1}{2kV^2}\frac{(R^2 - r^2)}{2kV^2}$$

Whether or not such a particle will reach the tube wall will depend upon whether its period in the downward helical path exceeds this time. This period depends on area, length, and flow.

$$\text{Period} = \frac{Al}{Q} = \frac{(\pi R^2 - \pi I^2)}{Q} l$$

Where I is the radius to the inner edge of the outer helical path.

If the particle is just brought to the wall at the bottom then:

$$\frac{1}{2kV^2}\frac{(R^2 - r^2)}{2kV^2} = \frac{\pi l}{Q}(R^2 - I^2)$$

Whether or not a particle of character k will settle or not depends upon its initial position r in the stream. If we consider that these particles are initially uniformly distributed in the helical stream and all particles at rotational radii greater than r are thrown to the wall then the percentage thrown to the wall will be:

$$\frac{R^2 - r^2}{R^2 - I^2} \times 100$$

Then by the above equation:

$$\text{Per cent removed to wall} = \frac{R^2 - r^2}{R^2 - I^2} \times 100 = \frac{2\pi l V^2 k}{Q} \times 100$$

if we know the diameter and density of the particles we might calculate k or we might determine it by settling test from its sedimentation velocity.

$$k = \frac{S}{g}$$

hence efficiency of Vortrap in throwing particles of settling velocity S to the tube wall.

$$\text{Efficiency} = \frac{2\pi l V^2 S}{Qg} \times 100$$

where

l = length of tube
V = tangential velocity
S = settling rate of particles
Q = flow
g = gravitational acceleration = 32 ft./sec.^{2}

According to this question the efficiency of dirt removal should be vastly improved by increase in velocity for the same flow. This equation also shows why in large capacity fluid Vortex separators which pass large flows but with the same velocity, the efficiency is less than in smaller ones which have lower flow.

Dirt thrown to the wall of the separator is not necessarily removed from the fluid. The actual dirt removal achieved in practice is dependent upon the theoretical efficiency predicted by this equation and the ability for the system to discharge dirt thrown to the wall. There appears also to be the added factor that fibrous or platelet-like particles (clay) tend to be oriented by the liquid shear in the system so that the discharge is considerably less than should be expected.

The Vortrap Degasser

This is the major part of the theory leading to the development of what we may call the Vortrap Classifier Degasser, capable of simultaneous removal of dirt and gas. A schematic cross section of the device showing fluid flow is shown in Fig. 3. Liquid is forced through a nozzle which converts pressure energy into velocity. This nozzle enters tangentially into the Vortrap tube causing the liquid to follow the wall in a helical path. The centrifugal force developed due to the high tangential velocity throws the dirt to the wall where it is swept along to the bottom, and discharged through a tangential outlet. The clean stock as it nears the bottom is turned up by action of a curved taper, spirals into smaller radius, and moves upward in a helical path. Due to the high velocity the liquid is forced by a centrifugal effect to leave a vacuum space in the center. The return inner upward moving helix is subject thus to reduced pressure which causes gases to come from solution to form bubbles which along with any bubbles

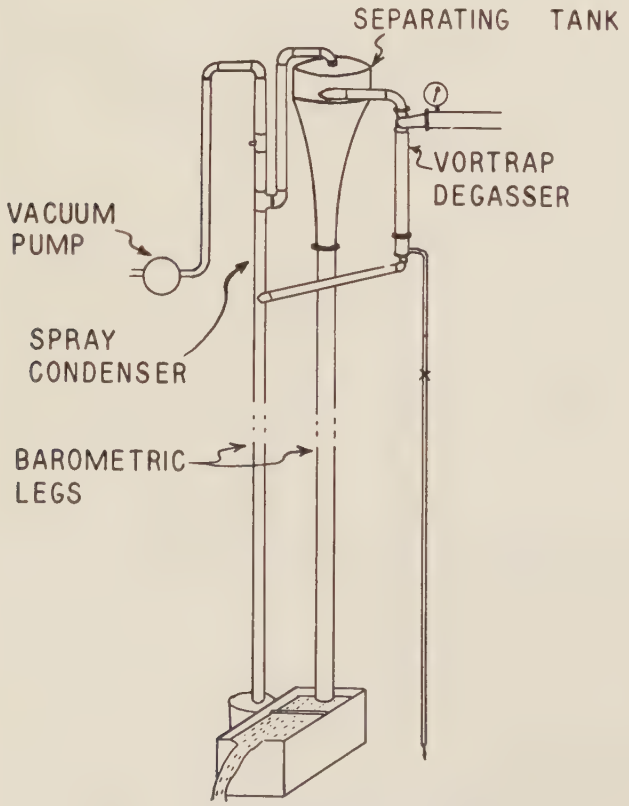


Fig. 4. Vortrap degasser installation

which may have originally existed are rapidly remove by centrifugal force to the core. A large proportio of such gases are removed from the core by a bottor pipe connected to a vacuum pump; the remainder i trapped with the stock and discharged to a separatin chamber.

The arrangement employed which successfull achieves simultaneous removal of dirt and gas fro stock is shown in Fig. 4. Stock enters the Vortra and flow and separation occur as indicated in the sch matic drawing and just discussed. Dirty stock discharged tangentially and since it leaves under slight pressure its flow may be controlled by a stoc valve. Part of the gas is removed to a spray condens and vacuum pump, the remainder removed from con bination but still mixed with the stock, is discharged t a small vacuum tank wherein it is separated and r moved by a pipe to the same spray condenser an vacuum pump. The clean stock is discharged fro the chamber and descends a barometric leg to a refine stock receiver or headbox.

Table IV. Performance of 4-In. Degassifying Vortra

Pressure, p.s.i.	15–35
Flow, U. S. g.p.m.	175
Dirt removal efficiency, %	50–85
Rejects, %	2 (adjustable)
Gas removal efficiency, %	80–90

The performance of this sytem is given in Table I The Vortrap degasser is flexible in its operating cond tion and gives quite efficient removal of both gas ar dirt.

DISCUSSION

Modern papermaking has, particularly with t development of the high-speed news machine, becon increasingly a precise operation. Many types of aux iary equipment have been proposed and used for t conditioning of stock. The removal of dirt, the ove coming of troubles arising from pitch accumulation, an more recently, the removal of gases from stock are a desirable steps in the conditioning of stock to the m chine, but altogether these steps involve a mass of equi ment (rifflers, classifiers, screens, Deculators, et and an increase in capital and operating costs whi have led the authors of this paper to seek means simplification.

The paper describes "Vortrap" classifier of improv efficiency for dirt removal which simultaneously moves gases from the stock. The full results of g removal have not yet been assessed but the autho emphasize that stock is obtained in a uniform state dispersal and leads to improved paper formatio These factors have been verified as an increased u formity in printability obtained on paper produced o machine operating on degasified stock. It is a claimed that pitch is subject to flotation by gas bubb and is found in a concentration on stock surfaces, le ing to lump accumulations in the machines. By moval of gas bubbles the pitch is left dispersed in t stock where it is probably not undesirable in pap making. Machine efficiency is improved, larger p portions of pitchy wood may be employed, and sb phite content may be affected favorably.

Received Dec. 16, 1952. Presented at the 38th Annual Meeting of Technical Association of the Pulp and Paper Industry, New York, N. Feb. 16–19, 1953.

ASSOCIATION NEWS AND EVENTS

Local Section Meetings

Pacific: May 21–23, 1953. Joint meeting with the Pacific Division, Superintendents Association, Gearhart Hotel, Gearhart, Ore.

Lake States: May 19, 1953. Butte des Morts Country Club, Appleton, Wis. Annual meeting.

Delaware Valley: May 28, 1953. Annual Edward J. Kilbert Competition Program; presentations by junior members.

New England and Maine-New Hampshire: June 19–20, 1953. Poland Spring House, Poland Spring, Me. Joint annual meeting.

Lake Erie: May 21–22, 1953. Carter Hotel, Cleveland, Ohio. Measurement and Control Conference.

CPPA Technical Section: June 4–6, 1953. Saranac Inn, Saranac, N. Y. Summer meeting.

Empire State Summer Meeting: The Empire State Section will hold its annual meeting at Whiteface Inn, Lake Placid, N. Y., on June 8–10, 1953. Room reservations should be made with H. W. Haynes, Manager. The technical program will include papers on the Deculator, Semichemical Pulping of Hardwoods, Elimination of Static Electricity, Odor Abatement, the Centricleaner, and Atomic Power.

Fourth Coating Conference

The Fourth Coating Conference of the Technical Association of the Pulp and Paper Industry will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on May 25–27, 1953.

Program of May 25, 1953

10:00 a.m. Symposium on Coated Papers in Offset Printing (Pavillon Caprice)

C. Zettlemoyer,, National Printing Ink Research Institute, Bethlehem, Pa., *Chairman*

1. "Coated Paper and Offset Printing, Part I," by A. P. Reynolds and "Part II," by F. H. Frost, S. D. Warren Co., Cumberland Mills, Me.
2. "Offset Inks for Coated Papers," by F. S. Dankert, Sun Chemical Co., East Rutherford, N. J.
3. "Offset Printing of Coated Papers," by Charles F. King, U. S. Printing & Lithograph Co., Cincinnati, Ohio.

12:30 p.m. Luncheon (where you will)

2:00 p.m. Symposium Continued (Pavillon Caprice)

4. "Nonpaper Factors and Quality of Offset Lithography," by David W. S. Riddell, The Montreal Lithographing Co., Ltd., Montreal, P. Q., Canada.
5. "Operating Factors in Offset Printing on Coated Papers," by Robert F. Reed and Gordon Wheeler, Lithographic Technical Foundation, Chicago, Ill.
6. Panel Discussion on "Factors Involved in Offset Printing of Coated Papers."

Program of May 26, 1953

9:00 a.m. Symposium on Coated Board (Pavillon Caprice)

P. Loomer, Robert Gair Co., Uncasville, Conn., *Chairman*

1. "Experience with the Champion Machine Coater on a Board Machine," by Glenn Renegar, Container Corp. of America, Manayunk, Pa.
2. "The Role of Calendering in the Machine Coating of Paperboard," by Harry C. Fisher, Gardner Board & Carton Co., Lockland, Ohio.
3. "Considerations in the Installation of High and Low Solids Machine Coaters on a Paperboard Machine," by A. W. Pomper, John Waldron Corp., New Brunswick, N. J.

12:30 p.m. Luncheon (Hall of Mirrors)

Address by Reuben B. Robertson, Jr., President, Champion Paper & Fibre Co., Hamilton, Ohio.

2:00 p.m. Symposium Continued (Pavillon Caprice)

4. "Customer Requirements for Coated Board," by O. M. Curtis, Jr., Lord Baltimore Press, Baltimore, Md.
5. Panel Discussion on "Machine Coating of Paperboard."

Program of May 27, 1953

9:00 a.m. General Session (Pavillon Caprice)

Richard T. Trelfa, Watervliet Paper Co., Watervliet, Mich., *Chairman*

1. "Considerations in the Design of a Universal Coating Machine for Paper and Board," by R. J. Jacobs, Dilts Machine Works, Fulton, N. Y.
2. "Physical Properties of Size-Pressed Coated Paper Containing Dow Latex 513-K," by Lloyd Silvernail, Dow Chemical Co., Midland, Mich.
3. "An Approach to the Evaluation of Coated Paper Smoothness," by Louis J. Scheid and Arthur Hupp, Watervliet Paper Co., Watervliet, Mich.

12:30 p.m. Luncheon (where you will)

8:30 a.m. Plant Visit

1. Mead Corp., Chillicothe, Ohio (by Baltimore & Ohio R.R. Train leaving Union Station, Cincinnati, at 8:50 a.m. E.S.T.)

1:30 p.m. Plant Visits

2. Gardner Board & Carton Co., Lockland, Ohio (by bus).
3. U. S. Printing & Lithograph Co., Cincinnati, Ohio (by bus).

Program of May 28, 1953

Plant Visit

Gearhart Meeting Program

The joint meeting of the Pacific Section of TAPPI and the Pacific Division of the Superintendents Association will be held at the Gearhart Hotel, Gearhart, Ore., on May 21–23, 1953. Among the subjects to be considered are the following:

"What Can Be Done to Improve Our Key People," by Mike Paul, Crown Zellerbach Corp., San Francisco, Calif.

"Preparation of Chlorine Dioxide Bleach–Sulphur Dioxide Reduction of Sodium Chlorate," by J. B. Heitman, Pennsylvania Salt Mfg. Co., Tacoma, Wash.

"Housekeeping in a Sulphite Mill," by L. R. Wood, Crown Zellerbach Corp., Camas, Wash.

"Ammonia vs. Calcium-Base Acid Making, Cooking and Screening," by Loran La Fond, Crown Zellerbach Corp., Lebanon, Ore.

"Evaporating and Burning Ammonia-Base Waste Liquor," by James Hull, Crown Zellerbach Corp., Camas, Wash.

"Lindblad Screens and Vortraps," by Gerald W. Hough, Weyerhaeuser Timber Co., Longview, Wash.

"Use of Centricleaners on General Mill Applications Other than Pulp Cleaning," by Fred R. Sievers, Crown Zellerbach Corp., Camas, Wash.

"Dirt Count Comparison with Oliver Ahlfors vs. Flat Screens," by M. G. Kapshinget and A. W. Strain, Columbia River Paper Mills, Vancouver, Wash.

"Centricleaners and Vortraps in an Unbleached Sulphite Mill," by Harlan Clodfelter, Spaulding Pulp & Paper Co., Newberg, Ore.

"Identification and Evaluation of Dirt in Pulp."

"Ahlfors Screens, Centricleaners and Vortraps in Kraft Pulp and Paper Mills," by Lloyd Heard, Longview Fibre Co., Longview, Wash.

Superintendents Association

Harry E. Weston, Secretary and Treasurer of the American Pulp and Paper Mill Superintendents Association, has announced that the Association offices are now located at 327 S. La Salle St., Chicago 4, Ill. Telephone—Webster 9-4743.

New Chairmen

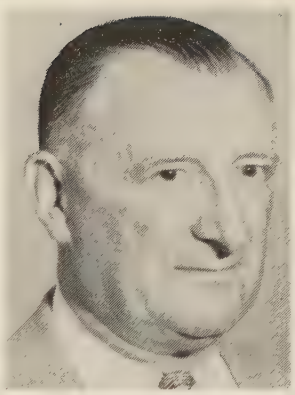
Albert V. Grundy, Chief of the Container Laboratories, Quartermaster Food & Container Institution for the Armed Forces, Chicago Quartermaster Depot, 1819 Pershing Rd., Chicago 9, Ill., has been appointed chairman of the TAPPI Container Testing Committee.

With him will serve W. J. Balster, Chicago, Charles J. Zusi, Container Testing Laboratories, Chicago, and Earl R. Stivers, Package Research Laboratory, Rockaway, N. J. R. S. Kurtenacker of the Forest Products Laboratory is expected to become a member of the committee at a later date.

This committee serves a dual role of being a major standards writing committee in the Testing Division and also being a subcommittee of the new Container Evaluation and Development Committee in the Converting and Consuming Division. As a subcommittee it will cooperate in the development of superior containers.

James P. Casey of A. E. Staley Mfg. Co., Decatur, Ill., has been appointed to the new position of vice-chairman of the TAPPI Testing Division assisting James d'A. Clark, general chairman. Mr. Casey is now chairman of the Nonfibrous Materials Testing Committee, a position that he expects to relinquish as soon as he can find a competent replacement.

John D. Lyall, Engineer of the Armstrong Cork Co., Lancaster, Ohio, has been appointed vice-chairman of TAPPI Engineering Division to assist Charles J. Sibler, Chief Engineer of the West Virginia Pulp & Paper Co., general chairman.



A. V. Grundy, Chicago Quartermaster Depot; Chairman, Container Testing Committee

J. D. Lyall, Armstron Cork Co.; Vice-Chairma TAPPI Engineering Div sion

Microbiology Monograph

The TAPPI Microbiology Committee under the chairmanship of B. F. Shema of The Institute of Paper Chemistry, Appleton, Wis., has appointed a Monograph Subcommittee consisting of J. W. Appling, Buckman Laboratories, Memphis, Tenn., chairman, G. A. Cruickshank, National Aluminate Corp., Chicago Ill., R. F. DeLong, Marathon Corp., Menasha, Wis., and himself to prepare a monograph on "Microbiology of Pulp and Paper." The publication is now being written. Its subject matter is outlined as follows.

I. Scope—J. W. Appling, Buckman Laboratories, Inc.
   A. The purpose of the monograph and the reason why the various sections are included
II. Introduction to Microbiology—G. A. Cruickshank, National Aluminate Co.
   A. The relationship of various microorganisms
   B. Algae
   C. Bacteria
   D. Fungi (covering the four main groups)
III. Microbiology of Pulpwood—B. F. Shema, The Institute of Paper Chemistry
   A. Principles
   B. Forest tree diseases
   C. Cutting and storage
      1. Barking
      2. Transit
      3. Storage
   D. Control measures
      1. In the forest
      2. In the woodyard
IV. Microbiology of Fresh Water—R. B. Martin, Wallace and Tiernan
   A. Principles
   B. Types of microorganisms
      1. Algae—protozoa—crustacea
      2. Bacteria
         a. Sulphate-reducing
         b. Iron
         c. Miscellaneous
      3. Fungi
   C. Source of water
      1. Wells
      2. Surface
         a. Normal flow
         b. Seasonal fluctuation
   D. Control measures
      1. Chlorination
         a. Chlorine
         b. Breakpoint chlorination
         c. Chloramines
      2. Chemicals for water treatment
      3. Effect of efficient water treatment upon slime
   E. Methods
      1. Bacterial numbers
      2. Chlorine residual
V. Preservation of Pulps—J. R. Sanborn, National Alun nate Co.
   A. Principles
   B. Effect of preparation
   C. Effect of bleaching
   D. Storage
      1. Slush
      2. Lap
   E. Chemical agents
   F. Methods
VI. Slimes in Mill System and Means of Control—J. V Appling, Buckman Laboratories, Inc.
   A. Principles
      1. Definition
   B. Types of slime
      1. Appearance
      2. Organisms
   C. Correlation between water utilization and slime co trol
   D. Control measures
      1. Physical
      2. Chemical
      3. Possible toxic levels
         a. Stream pollution
         b. Humans and animals
   E. Methods
      1. Causative organisms
      2. Evaluation of slimicides in the laboratory and the mill
VII. Felt Deterioration—B. F. Shema, The Institute of Pa Chemistry
   A. Principles
   B. Structure of felts
   C. Susceptibility to bacterial action
      1. Effect of chemical agents
      2. Effect of physical agents
   D. Control measures
      1. Pretreatment
      2. Machine treatment
   E. Methods
      1. Means of detection
      2. Means of evaluation of chemicals
VIII. Other Deterioration Problems—C. G. Humiston, L Chemical Co.
   A. Coating and sizing
      1. Principles
      2. Enzyme conversion of starch
      3. Control measures
         a. Chemical agents
         b. Sanitation practices
      4. Methods
   B. Miscellaneous
IX. Preservation of Paper Products—B. F. Shema, Institute of Paper Chemistry
   A. Principles
   B. Mold-resistant grades
   C. Chemical agents
   D. Methods
X. Food Packaging Materials—R. F. DeLong, Marat Corp.

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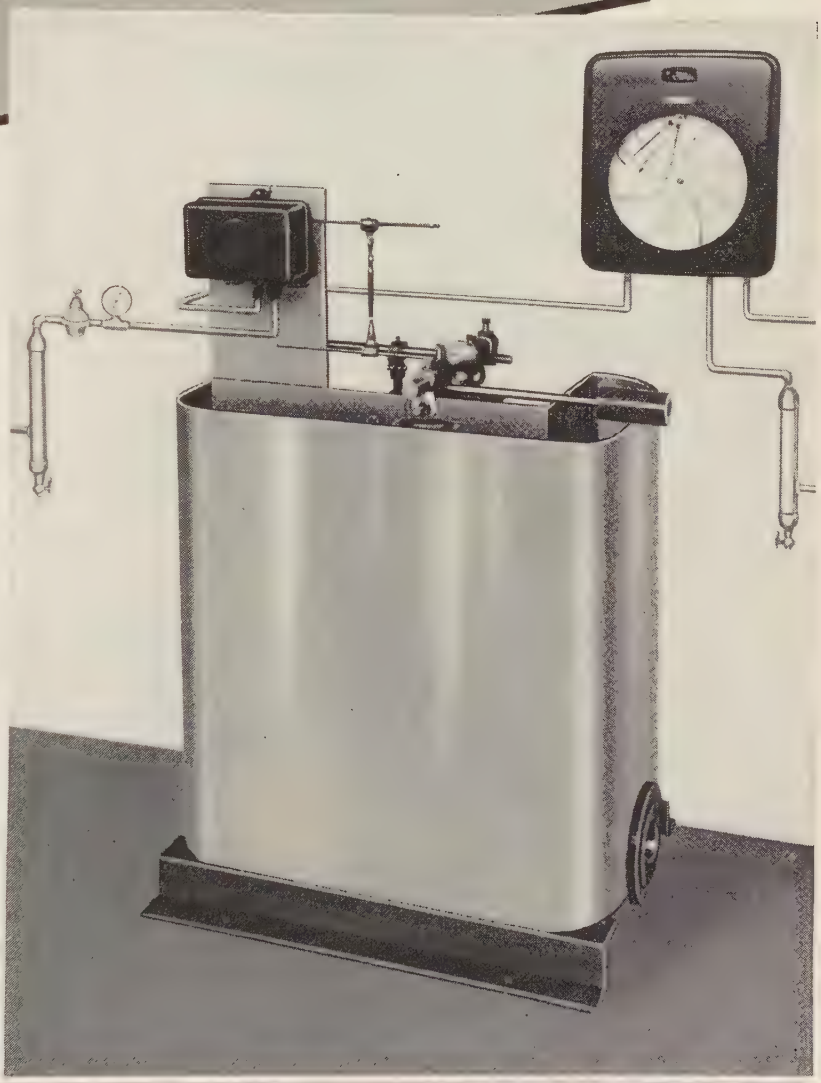

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A. Principles
B. Microbiological quality
   1. Effect of manufacturing process
   2. Effect of conversion process
C. Public health aspects
D. Methods
   1. Laboratory tests
   2. Packaging tests

XI. Microbiology of Spent Sulphite Liquors—A. J. Wiley, Sulphate Pulp Manufactures Research League, Inc.
A. Principles
B. Processes
C. Methods

XII. Miscellaneous Problems—R. F. DeLong, Marathon Corp.
A. Corrosion of equipment by sulphate-reducing bacteria
   1. Principles—recognition
   2. Control measures
   3. Methods
B. Odors in paperboard of microbiological origin
   1. Principles—recognition
   2. Means of control
   3. Methods

TAPPI Office Changes

During the current month A. John Winchester joined the staff of the Association. Mr. Winchester was formerly Groundwood Superintendent of the Donnacona Paper Co., Donnacona, Que.

The central office of the Technical Association of the Pulp and Paper Industry will move in June from 122 E. 42nd St. to 155 E. 44th St., New York 17, N. Y. The date for moving is not definite. Letters may be addressed to the Association at its present address until further notice.

Joint Textbook Committee

Volumes I and II of "Pulp and Paper Manufacture" have already been issued. Volumes III and IV are still in preparation. Volume III is expected to be ready for distribution in a few months. The administrative and financial problems relating to this important set of texts is handled by the

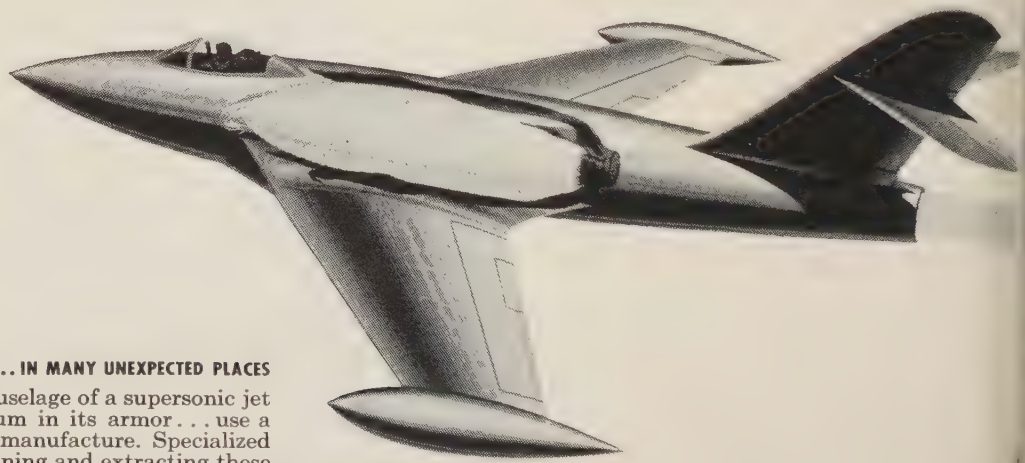
Joint Textbook Committee, representing the pulp and pape industry in the United States and Canada.

The photograph of the members of the committee was take during the recent Annual Meeting of TAPPI in New York From left to right are shown: Raymond S. Hatch, Hudso Pulp & Paper Co., Palatka, Fla.; Royal S. Kellogg, Secretary Palmetto, Fla; Harry S. Spencer, Howard Smith Paper Mill Beauharnois, P. Q.; Chairman, R. G. Macdonald, TAPP New York, N. Y.; Douglas Jones, CPPA Technical Sectio Montreal, P. Q.; J. Newell Stephenson, Gardenvale, P. Q Editor, and John Zima, Secretary of the News Print Servic Bureau.

Mullen Tester Calibration

Aluminum foil for the calibration of Mullen testers ma now be obtained from the Testing Foil Service, 304 N. Steven St., Rhinelander, Wis. This foil was formerly supplied to t industry by the Hurlbut Paper Co. who discontinued th service in September, 1952.

what's **corn** doing
breaking through the sound barrier?



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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Ellis Abrams, Chemist, Quaker Chemical Products Corp., Conshohocken, Pa., a 1942 graduate of the University of Pittsburgh with a Ph.D. degree.

George G. Acheson, Product Development Manager, E.S.&A. Robinson (Canada) Ltd., Leaside, Ont., Canada, a 1940 graduate of University of Manitoba.

Leonard Allman, Sales Engineer, Newcomb-Detroit Co., Detroit, Mich. Attended Drexel Institute of Technology.

Henry N. Armbrust, Engineer, Proportioneers, Inc., Providence, R. I., a 1924 graduate of the University of Rhode Island.

John Austin, Research Chemist, Catalin Corp. of America, Fords, N. J., a 1929 graduate of the Technical University of Vienna.

William C. Barnwell, Assistant Chief Engineer, Gaylord Container Corp., Mill Div., Bogalusa, La., a 1933 graduate of Mississippi State College.

William A. Barrett, General Manager, W. P. Evans & Son Ltd., Nashua, N. H., a 1933 graduate of Bury Technical College, Bury, England.

Lawrence C. Bathon, Administrative Assistant, Elk Paper Mfg. Co., Childs, Md., a 1949 graduate of Loyola College.

Frederic C. Battell, Librarian, Minnesota & Ontario Paper Co., Minneapolis, Minn. Degrees from Iowa State College, State University of Iowa, and Columbia University.

Francis W. Bell, Manager, Engineering Div., Brown & Root, Inc., Houston, Tex., a 1936 graduate of the University of Michigan.

Donald M. Black, Research and Development Chemist, Monsanto Chemical Co., Everett, Mass., a 1942 graduate of Rensselaer Polytechnic Institute, with a Ph.D. degree from Massachusetts Institute of Technology in 1947.

John D. Bolland, Assistant Director of Research, British Rayon Research Assn., Urmston Nr. Manchester, England, a 1935 graduate of Edinburgh University, with a Ph.D. degree in 1937.

John A. Bolt, Division Director, Standard Oil Co. (Ind.), Whiting, Ind., a 1930 graduate from the University of Michigan.

Harold M. Canavan, Chief Inspector, Boiler Div., Mutual Boiler & Machinery Insurance Co., Boston, Mass., a 1930 graduate of Wentworth Institute.

Roberts G. Carder, Vice-President, Whitefored Paper Co., Inc., New York, N. Y., a 1948 graduate of the University of Southern California.

John G. Cella, Chemical Engineer, Lowe Paper Co., Ridgefield, N. J., a 1947 graduate of Lehigh University.

Eugene D. Clark, Research Chemist, Solvay Process, Allied Chemical & Dye Corp., Syracuse, N. Y. a 1950 graduate of Tufts College.

Murl J. Cook, Chief Chemist, Fleming & Sons, Inc., Dallas, Tex., a 1950 graduate of Southern Methodist University.

William H. Crozier, Jr., Laboratory Supervisor, Byron Weston Co., Dalton, Mass.

Norbert J. Cumps, Plant Superintendent, Green Bay Box Co., Green Bay, Wis.

Richard A. Dando, Chemical Engineer, St. Regis Paper Co., Deferiet, N. Y., a 1948 graduate of Clarkson College of Technology.

Thurlow W. Davis, Technical Director, Stewart Hartsh Co., Oswego, N. Y., a 1927 graduate of Dartmouth College

George M. Dick, Chief Engineer, Canadian Ingersoll-R Co. Ltd., Montreal, P. Q., Canada, a 1924 graduate of Mc University.

Thomas E. Digby, Plant Engineer, Container Corp. America, Fernandina Beach, Fla., a 1929 graduate of Citadel.

Dave C. Dowd, Vice-President and General Mana Charles Dowd Box Co., Inc., Worcester, Mass.

Franklin P. Emerson, Assistant Superintendent, W Dudley Paper Co., Div. of Rhode Island Cardboard West Dudley, Mass., a 1949 graduate of Worcester Polyte nic Institute.

Frank E. Field, Chemical Engineer, Sutherland Paper Kalamazoo, Mich., a 1951 graduate of Michigan State Coll

Robert Fraser, Assistant to Production Manager, Abi Power & Paper Co. Ltd., Toronto, Ont., Canada, a 1 graduate of Nova Scotia Technical College.

Gordon J. Gill, Chemist, Solvay Process, Syracuse, N. Y 1950 graduate of Western Michigan College.

Harvey J. Gill, Jr., Research Chemist, Carr, Adams Collier Co., Dubuque, Ia., a 1940 graduate of the Univer of Dubuque.

Foskett H. Godfrey, Manager, A. E. Broughton & Co., G Falls, N. Y. Attended Finsbury Institute.

Pierre P. Goldsmith, Chemist, Columbia River Paper Vancouver, Wash., a 1938 graduate of University of Gren with a Ph.D. degree.

George A. Hadlow, Plant Superintendent, St. Regis P Co., Carthage, N. Y.

John T. Harrison, Plant Manager, Union Bag & P Corp., Chicago, Ill., a 1931 graduate of Massachusetts stitute of Technology.

William D. Haskin, Student, New York State Colleg Forestry, Syracuse, N. Y.

Max Hefti, President, Cesalpinia, S.p.A., Milan, Italy.

Elbert A. Henry, Jr., Area Engineer, Riegel-Carolina Co Acme, N. C., a 1950 graduate of the University of Arkansa

Leander H. Hills, Supervisor and Development Engin Garlock Packing Co., Palmyra, N. Y., a 1917 graduat Massachusetts Institute of Technology.

David C. Howard, Laminating Superintendent, Amer Coating Mills, Elkhart, Ind.

Yanosuke Inaba, Director, Central Research Laborat Toyo Koatsu Industries, Ltd., Yokohama-shi, Japan, a 1 graduate of Tokyo Imperial University with an Eng.D. deg

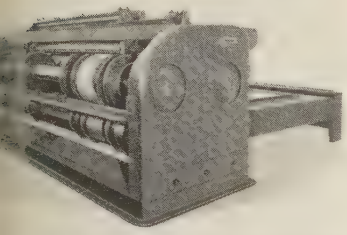
Yoshio Ishikawa, Chief Engineer, Bleaching Dept., K saku Pulp Co., Ltd., Tokyo, Japan, a 1935 graduate of Y gawa Technical College.

Robert L. Jenk, Group Leader, The Mead Corp., Chillico Ohio, a 1943 graduate of Iowa State College.

Bert Jones, Chemist, Robert Gair Co., Inc., Soutl Paperboard Div., Port Wentworth, Ga., a 1951 graduat the University of Georgia.

Kaziwara Kagemitsu, General Director, Saga Straw B Mfg. Co., Tokyo, Japan, a 1933 graduate of Kyushu Imp University.

Robert W. Kent, Paper Mill Engineer, Champion Pap Fibre Co., Pasadena, Tex., a 1949 graduate of the Unive of Texas.



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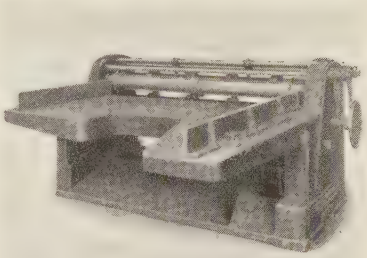
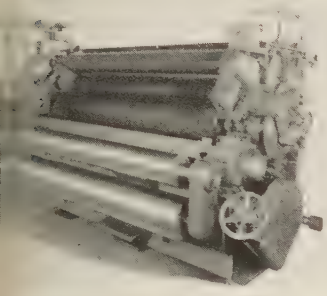
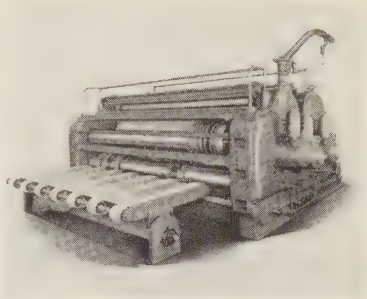


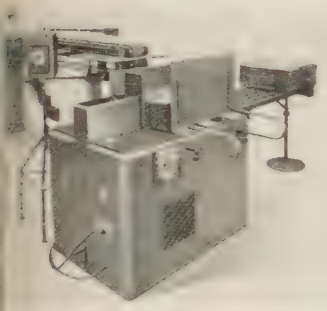
S & S SLITTER-SCORER



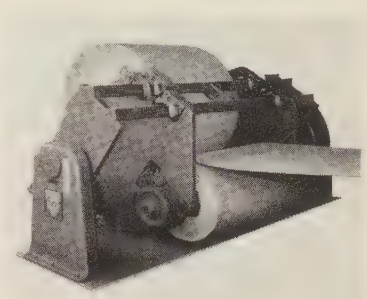
S & S SINGLE FACER



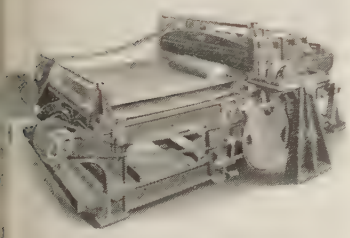
S & S PRINTER-SLOTTER



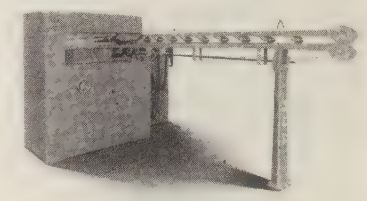
S & S COUNTER-STACKER



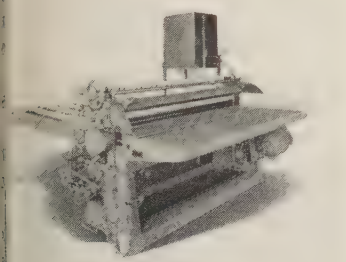
S & S MILL ROLL STAND



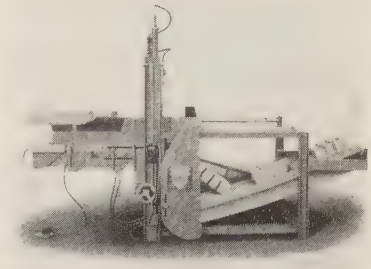
S & S SHEET CHOPPER



S & S ONE GIRL LAP GLUER



S & S PARAFFINER



S & S PARTITION ASSEMBLER

S & S

CORRUGATED PAPER MACHINERY CO., INC.

160 NORTH 4TH STREET

BROOKLYN 11, N.Y.

Founded 1917

Harold V. Kindseth, Superintendent of Research and Development, Bemis Bro. Bag Co., Minneapolis, Minn., a 1931 graduate of the University of Minnesota.

Osamu Kishi, Chemical Engineer, Kokusaku Pulp Mill, Tokyo, Japan, a 1941 graduate of Kyoto University.

William M. J. Lewis, Jr., Draftsman, West Virginia Pulp & Paper Co., Mechanicsville, N. Y., a 1952 graduate of Rensselaer Polytechnic Institute.

Alfred H. Lindquist, Plant Engineer, Fibreboard Products, Inc., San Joaquin Div., Antioch, Calif., a 1931 graduate of Stanford University.

Howard F. Lipscomb, Superintendent, No. 2 Mill, Champion Paper & Fibre Co., Hamilton, Ohio.

Frits Madsen, Sales Manager, B-C International Ltd., London, England, a 1941 graduate of Royal Technical Academy, Copenhagen.

Charles H. Mayhood, Jr., Student, New York State College of Forestry, Syracuse, N. Y.

Edward H. Meyer, Public Relations, Paper Chemicals, American Cyanamid Co., New York, N. Y., a 1951 graduate of New York State College of Forestry.

Henry T. Michael, Chemist, Champion Paper & Fibre Co., Canton, N. C., a 1936 graduate of North Carolina State College.

Frank E. Monks, Research and Development Engineer, Fuller Label & Box Co., Pittsburgh, Pa., a 1947 graduate of Carnegie Institute of Technology.

Robert C. Montana, Plant Engineer, Robert Gair Co., Inc., New York, N. Y., a 1941 graduate of Massachusetts Institute of Technology.

Ishigami Naoyuki, Head of Manufacturing Dept., Rengo Shiki K.K., Osaka, Japan, a 1921 graduate of A. Kumamoto Technological College.

Robert E. Noble, Technical Service Supervisor, Hooker Electrochemical Co., Tacoma, Wash., a 1939 graduate of Montana State College.

Charles F. North, Resident Engineer, Cummins & Barnard, Inc., Ann Arbor, Mich., a 1949 graduate of the University of Michigan.

Theodore C. Perdziak, Plant Superintendent, J. W. Clement Co., Buffalo, N. Y.

Ernest Perrigo, Superintendent, St. Regis Paper Co., Carthage, N. Y.

C. Cline Peters, Assistant Plant Engineer, Riegel-Carolina Corp., Acme, N. C., a 1941 graduate of Virginia Polytechnic Institute.

Robert J. Pfeiffer, Supervisor, Charles Bruning Co., Inc., Teterboro, N. J., a 1949 graduate of Seton Hall College.

Edward L. Rastatter, Technical Director, Bauer Bros. Co., Springfield, Ohio, a graduate of Pennsylvania State College.

Jesse E. Ray, Manager, Quality Testing Laboratories, Scott Paper Co., Chester, Pa., a 1952 graduate of the University of Maine.

Marshall F. Reid, Director, Lyddon & Co. Ltd., London, England, a 1922 graduate of Aberdeen University.

Harold C. Richardson, Managing Director, Gummed Products Pty. Ltd., Sydney, Australia, a graduate of Sydney Technical College.

Thomas R. Scanlan, Jr., Sales, Hart Products Corp., New York, N. Y., a 1950 graduate of Philadelphia Textile Institute.

Charles Schenker, Research Chemist, The Procter & Gamble Co., Cincinnati, Ohio, a 1949 graduate of Cornell University with a Ph.D. degree.

Lawrence L. Shailer, Jr., Chemical Engineer, B. F. Goodrich Chemical Co., Cleveland, Ohio, a 1943 graduate of the University of Illinois.

Jimmie M. Smith, Chemical Engineer, Robert Gair Co., Inc., Southern Paperboard Div., Port Wentworth, Ga., a 1951 graduate of the University of North Carolina.

Elvin A. Stafford, Research Chemical Engineer, Buckeye Cotton Oil Co., Memphis, Tenn., a 1951 graduate of Louisia State University.

John J. Sullivan, Jr., Development Engineer, Lowe Pa Co., Ridgefield, N. J., a 1950 graduate of New York St College of Forestry.

John W. Swanson, Research Associate, The Institute Paper Chemistry, Appleton, Wis., a 1940 graduate of Mo ingside College.

Douglas L. Tait, Assistant General Manager, Hygrade C tainers Ltd., London, Ont., Canada, a 1932 graduate of University of Toronto.

Larry L. Thompson, Engineer, Brunswick Pulp and Pa Co., Brunswick, Ga., a 1945 graduate of Georgia Institute Technology.

Andre Jean Tourreil, Consulting Engineer, Papeteries France, Paris, France, a graduate of Ecole Polytechniq Paris.

Harold S. Vanderhei, Chief Engineer, Combined Lo Paper Co., Combined Locks, Wis.

Harold H. Webber, Consultant, Harold H. Webber L oratories, Groton, Mass., a 1941 graduate of the Univers of Texas.

Alfred B. Wells, Assistant Manager, Crucible Steel Co. America, Atlanta, Ga. Attended the University of Pittsbu and Carnegie Institute of Technology.

Robert A. Wheeler, Chemical Engineer, The Texas C Port Arthur, Tex., a 1948 graduate of the University of Tex

Peter M. Wilkie, Kraft Mill Shift Foreman, Crown Zel bach Corp., Camas, Wash., a 1939 graduate of Mont State College.

Norman T. Woodberry, Research Chemist, Paper Chemi Laboratory, American Cyanamid Co., Stamford, Conn. 1939 graduate of Brown University and a 1946 graduate Polytechnic Institute of Brooklyn.

TAPPI Notes

Harold R. Alley, formerly of the National Research Cou is now Technical Director of the Mid-West Wax Paper C Fort Madison, Iowa.

Luther C. H. Beighey, formerly of the Hammermill P Co., is now Mill Superintendent of the Irving Pulp & P Co., Ltd., St. Johns, N. B.

William T. Bennett, formerly of P. H. Glatfelter Co. now with the Halifax Paper Co., Roanoke Rapids, N. C.

C. O. Berggren has returned from the Army to the Pers Products Corp., Milltown, N. J., as a Paper Technologist.

Fred W. Bishop is now Chief Chemist of the Southl Paper Mills, Inc., Lufkin, Tex.

Alfred D. Bonanno, formerly of the Champion-Internati Co., is now Technical Representative for Kelco Co., Chic Ill.

John H. Brooks, formerly of the Glassine Paper Co., is Engineer for the Westfield River Paper Co., Russell, Mas

Mats De Verdier, formerly of Elof Hanson, Inc., is Assistant Sales Manager of Fiskeby Fabriks A/B, Norrk ing, Sweden.

Karl O. Elderkin, Vice-President of TAPPI, represented Association at the annual meeting of the Technical Sect British Paper and Board Association, held recently in Lon

Frederick H. Frost is now Vice-President in Charge of search of S. D. Warren Co., Cumberland Mills, Me.

Walter M. Goodwillie, formerly of United Container C now General Manager of Daring Paper Co., Bridgeport, P

Julius Grant, formerly of Thomas Owen & Co., Ltd., is Technical Consultant for Hehner & Cox Ltd., London, land.

Walter F. Holzer is now Vice-President of the Crown Ze bach Corp., 343 Sansome St., San Francisco 19, Calif.

Harry Hulmes, Jr., formerly of Williams Gray Co., is Sales Representative for the Lindsay Wire Weaving Cleveland, Ohio.

Efficient Exhaust and No Space Wasted

"Buffalo"

VANEAXIALS
Mounted in Vertical Exhausts

Roof Installation
of Paper Company Points
Way to Savings in Many Industries

Above are part of the ten 36" "Buffalo" Type "B" Vaneaxial Fans mounted in roof exhausts of West Virginia Pulp and Paper Co., Mechanicville, N. Y. Note how the fans fit in like a section of pipe. Their light weight obviates heavy, expensive mountings, and the fans waste no space. The steam comes from hoods from Nos. 5 and 6 paper machines—and passes straight through the pipes and fans with absolute minimum resistance. (At right, note how motor is entirely removed from air stream). Whenever YOU need fans for mounting in straight duct runs, you'll save money with "Buffalo" Vaneaxials.

YOURS! This Helpful Bulletin No. 3533-C! Describes "Buffalo" Axial Flow Fans and their uses. Write for your copy!

"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

528 BROADWAY BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

DIAMOND JUBILEE 75TH ANNIVERSARY

VENTILATING | PRESSURE BLOWING | AIR CLEANING | COOLING | AIR TEMPERING | HEATING | INDUCED DRAFT | FORCED DRAFT | EXHAUSTING

Everett P. Ingalls is now Vice-President in Charge of Manufacturing of S. D. Warren Co., Cumberland Mills, Me.

Carl G. Krancher, formerly of Ball Bros. Co., is now with Alton Boxboard Co., Alton, Ill.

Frank B. Lincoln, Jr., is now Manager of Paper Research and Development of the Springdale Laboratories, Time, Inc., Springdale, Conn.

Clement E. Lovely is now Assistant Manager of the Adhesives Sales Service of Philadelphia Quartz Co., Philadelphia, Pa.

Walter J. Macey, Chemist for the St. Regis Paper Co., has been transferred from Watertown, N. Y., to Pensacola, Fla.

Gerald L. MacKinnon, formerly of the Rogers Corp., is now Production Manager of the U. S. Bobbin & Shuttle Co., Lawrence, Mass.

Donald G. Magill has returned from the Navy to the Riegel Paper Corp., Milford, N. J., as Chemist.

Robert E. March, formerly of the Marinette Paper Co., is now Technical Director of the Scott Paper Co., Chester, Pa.

Lawrence A. Moore, formerly of the American Coating Mills, is now assistant Chief Engineer of the Black-Clawson Co., Hamilton, Ohio.

Leo P. Newtown, formerly of the Dunn Paper Co., is now General Superintendent of Canadian Glassine Ltd., Quebec, P. Q.

Richard A. Nugent, formerly Superintendent of the Nekoosa-Edwards Paper Co., Nekoosa, Wis., is now Planning Engineer at the Port Edwards mill.

Harry E. Patterson is now Supervisor of Preventive Maintenance for the Wood Conversion Co., Cloquet, Minn.

Ralph N. Prince, formerly of the American Cyanamid Co., is now Technical Superintendent of J. & J. Rogers Co., Au Sable Forks, N. Y.

Thomas E. Ramsey is now Manufacturing Superintendent of the Ecusta Paper Corp., Pisgah Forest, N. C.

Kenneth L. Rawlinson, formerly of the Burroughs Adding Machine Co., is now General Foreman in Charge of Production of Mittag & Volger, Park Ridge, N. J.

Howard S. Rish is now Vice-President of the American Coating Mills Div. of Robert Gair Co., Elkhart, Ind.

Roy D. Rivers is now Superintendent of Operations of the Ballarpur Paper & Straw Board Mills Ltd., Ballarpur, India. Mr. Rivers advises that the new mill is the first to run entirely on bamboo pulp, the first using the kraft pulping process.

John R. Rogers is now Assistant Manager and Purchasing Agent of J. & J. Rogers Co., Au Sable Forks, N. Y.

Joseph Schonberg, formerly of Albert N. Weiss Co., is now General Manager of Eastern Chippewa Paper Products Co., South Hackensack, N. J.

G. Robert Sido, Chemist for the Monsanto Chemical Co., has been transferred from Springfield, Mass., to the Plastics Div., Port Plastics, Ohio.

I. J. Stafford is now Vice-President of the Neenah Paper Co., Neenah, Wis.

Sam S. Stevens, formerly a Consultant, is now General Manager of the Erving Paper Mills, Erving, Mass.

Royal A. Stone, formerly of Olin Industries, Inc., is now Chief Draftsman for Merritt, Chapman & Scott, New York, N. Y.

John H. Symes, formerly of Piedmont Paper Products, Inc., is now Assistant Chief Chemist of the National Container Corp. of Virginia, Big Island, Va.

Joseph F. Thompson, formerly Technical Director, is now Vice-President in Charge of Research and Development of Minerva Wax Paper Co., Minerva, Ohio.

Vincent H. Urquhart, formerly of Seabord Container Corp., is now Plant Manager of the National Container Corp. of Indiana, Aurora, Ind.

Robert F. Vokes is now General Manager of Dilts Machine Works, Fulton, N. Y.

Harry E. Weston, Secretary of the American Pulp and Paper Mill Superintendents Association, has moved his office from 111 W. Washington St. to 327 S. La Salle St., Chicago, Ill.

Clayton B. Willis is now Vice-President and Sales Manager of Industrial Chemical Specialties Co., Fort Worth, Tex.

C. J. Witkowski, formerly of Shartle Bros. Machine Co., is now Technical Director of Ancram Paper Mills, Ancram, N. Y.

* * *

Paul Turel has succeeded *Pierre Delcroix* as the official representative in TAPPI of Association Technique de l'Industrie Papeterie Paris, France.

* * *

Maurice J. Landberge has succeeded *Fred A. Soderberg* as the official representative of the General Dyestuff Corp. in TAPPI.

Frederic A. Soderberg has succeeded *Harold S. Dahlberg* as the official representative of F. C. Huyck & Sons, Rensselaer, N. Y.

Industry Notes

Production

The complete census report on pulp, paper, and paperboard production is published in this issue of *Tappi*.

The total production of paper and paperboard, including newsprint in February, 1953, is estimated at 2,106,000 tons, 100,000 tons more than February, 1952. In January and February the production was 4,311,928 tons or about 5% more than the first two months of 1952. The increase was due primarily to gains made by building boards and paperboard. The largest decreases occurred in the fine paper and coated paper grades in which production was 13.9 and 5.5% less respectively.

Dissolving Pulp

Cellulose consumption by the rayon and acetate industry fell off by 11% to 549,500 short tons in 1952, compared with 1951 (616,300 tons). The greatest decrease was in the consumption of cotton linters (36% decline). The decrease in wood pulp was 6%.

Wastepaper

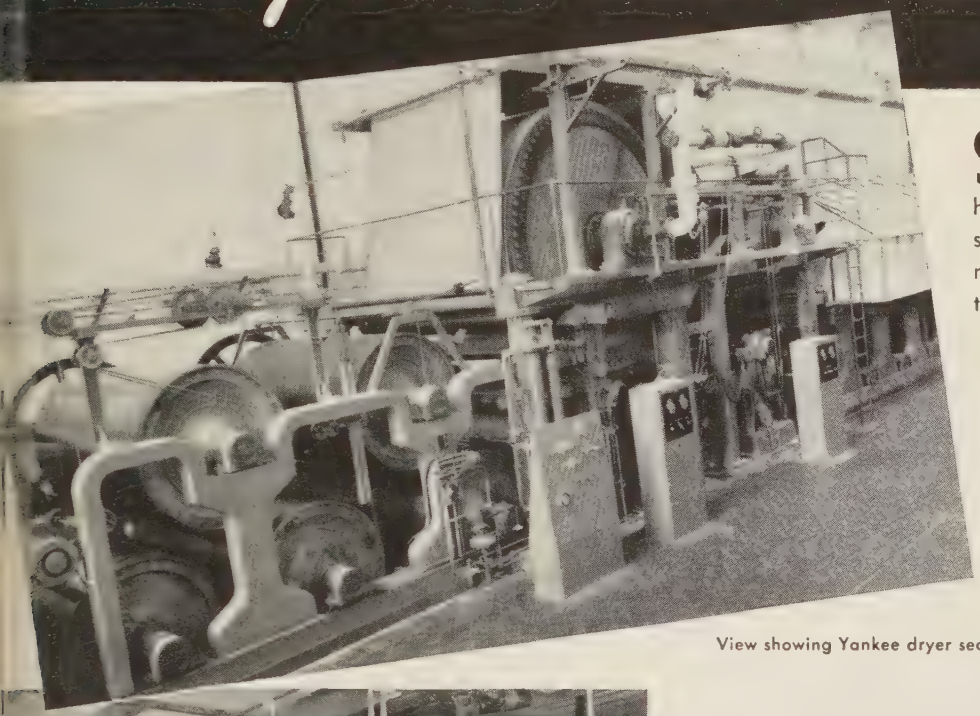
Per capita salvage of wastepaper by the people of the United States averaged 20.3 lb. less in 1952 than in 1951. Last year the per capita recovery of wastepaper averaged 102.2 lb.; the previous year it averaged 122.5 lb.

The story can best be told by carefully reading the following comparative tables compiled by this office from statistics supplied by the Bureau of Census:

	1951	*1952*
Population of U. S.	154,353,000	155,767,000
Total U. S. production of paper and paperboard, tons	26,048,000	24,413,000
Total imports to U. S. of paper and paperboard, tons	5,139,254	5,173,000
Total production and imports of paper and paperboard, tons	31,187,254	29,586,000
Total exports, paper and paperboard, tons	527,895	498,000
Total U. S. consumption of paper and paperboard, tons	30,659,357	29,088,000
Average per capita consumption, paper and paperboard, lb.	397.2	374
Wastepaper, purchased by consumers, tons	9,252,000	7,813,000
Wastepaper, exported, tons	206,438	144,000
Wastepaper, total salvaged, tons	9,458,438	7,957,000
Wastepaper, salvaged per capita, lb.	122.5	102
Ratio of recovery of wastepaper to consumption of paper and paperboard, %	30.8	27

Leading the Way to Greater Production!

Sandy Hill Board Machines



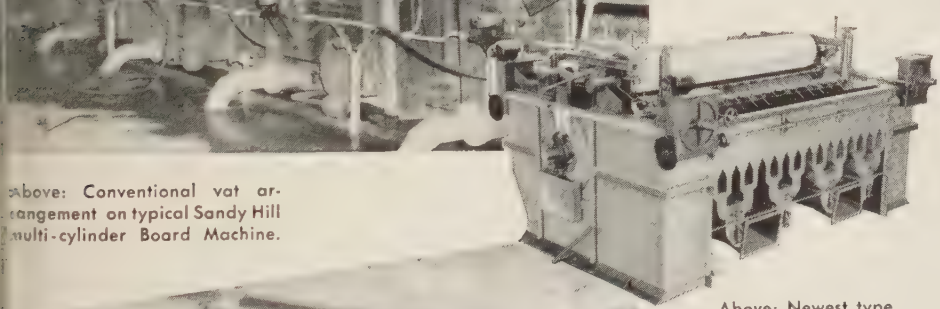
View showing Yankee dryer section.

Sandy Hill engineering "know-how", designing and production skill are responsible for the many outstanding features in the new Board Machines:

- Uniform weight and caliper and smoothness for good printability for *all types of board.*
- Production at *high* board machine speeds

Above: Conventional vat arrangement on typical Sandy Hill multi-cylinder Board Machine.

The Sandy Hill multi-cylinder Board Machine can be designed to meet the individual requirements of *your* mill. It may be built, for example, with more or fewer vats, a mill-determined number of presses, dryers or calenders, or such variations as may be decided by consultation between the men who use it and the men who build it.



Above: Newest type Cylinder Vat with movable mould and Sandy Hill-Bertrams manifold inlet.

These board machines in their basic design incorporate many features of Sandy Hill conception, such as multiple manifold stock delivery to the vat, movable cylinder moulds, open and accessible dryer framing, open-side calender framing, Yankee dryer and the selective drive.

At left: Open-side Calenders with new Sandy Hill anti-friction bearings and pneumatic load and lift.

The Sandy Hill
IRON & BRASS WORKS
PAPER MACHINERY SPECIALISTS • HUDSON FALLS, N. Y.

Associated with Canadian Vickers, Ltd., Montreal, Builders of Sandy Hill Designed Machinery in Canada

Pulpwood and Wood Pulp

Total receipts of pulpwood in January amounted to 2,259,000 cords, a decrease of 16% under receipts for January, 1952. Pulpwood consumption in January was 2,284,000 cords, a decline of 2% under January, 1952.

January wood pulp production totaled 1,471,000 tons, an increase of 3% over January, 1952. Consumption of wood pulp in January amounted to 1,567,000 tons, a 3% increase.

Capacity Increases by New Machines

Following is a schedule of new papermaking machine installations planned by machine manufacturers, as recently released by the Writing Paper Manufacturers Association, including a summary of the increased paper production capacity that will result. (Some of the machines scheduled for completion in 1953 may not be in operation until 1954.) Capacity given in rated 6-day basis;

Grade	*Capacity end of 1951*	*Capacity added in 1952*	*Capacity expected in 1953*	*Proposed capacity additions for 1954*
Fine	1,326,000	44,000	12,000	None
Book uncoated	1,626,000	None	None	None
Machine coated	1,120,000	None	None	None
Groundwood uncoated	739,000	None	None	None
Newsprint	1,052,000	31,000	34,000	217,000
Tissue	1,409,000	32,000	16,000	None
Wrapping and special industrial	3,798,000	163,000	356,000	None
Building paper	1,389,000	None	None	None
All other paper	112,000	None	None	None
Paperboard and building board	13,750,000	231,000	787,000	308,000
Total	26,321,000	501,000	1,205,000	525,000

Note: Above does not include additions or betterment of existing machines

Philippines

The Andres Soriana interests of the Philippines are planning the construction of a pulp and paper mill located on the Cateel River in the Bislig Bay area of Surigao, Mindanao. Most of the wood requirements for the 205-ton daily pulp output would be met from logging and sawmill waste operations.

New Zealand

Press reports from New Zealand state that the U. S. Export-Import Bank has agreed to advance $15,715,000 toward the construction of the Murapara newsprint, pulp, and timber project. The cost of the entire project is stated at $60,665,000. Construction of the mill will commence in September. Plant capacity is said to be 75,000 tons of newsprint and 36,000 tons of kraft annually.

Alaska

The Georgia Pacific Co. has proposed the construction of a pulp and newsprint plant near Juneau, Alaska, costing $56,511,000 with a rated production of 96,000 tons. Application for a certificate of necessity has been filed with NPA.

East Texas

The East Texas Pulp and Paper Co. plant to be constructed at Evadale, Tex., is expected to begin operations early in 1955; $25,000,000 of capital will be raised through borrowing $13,750,000 from institutional investors, while $8,000,000 will be furnished by Time and $3,250,000 by Houston Oil Co.

Scandinavian

Swedish, Norwegian, and Finnish pulp producers met in Stockholm on March 3 to discuss limitation of production to 90% of the 1951 figure. This would result in 1953 production being on a par with production in 1952.

Sawgrass

Press reports state that plans are under way to build a $500,000 mill near Belle Glade, Fla., for the production of newsprint from sawgrass. The mill is expected to be in operation within 9 months, producing from 40 to 50 tons of newsprint a day.

Finland

Mechanical Wood Pulp

Exports of mechanical pulp totaled 143,443 tons in 19 against 209,738 tons in 1951. Exports thus contracted 31.6%. The largest buyers were the U.K. 71,829 tons (12 219 tons in 1951), France 18,423 tons (32,886 tons), the U.S 16,867 tons (15,105 tons), the U.S.S.R. 12,010 tons and Arg tina 7730 tons (9153 tons).

The value of exports diminished 42%, from 4.8 thous million to 2.7 thousand million marks.

Finland's mechanical pulp production as a whole, includ the domestic utilization of mechanical pulp for the manufact ing of paper, board, etc., amounted to 723,000 tons, 10.4% than the 1951 figure.

Thanks to the voluntary contraction of 20% in mechan pulp output in the northern countries the commodity's c merical status improved somewhat at the end of the y This was also true, in part, to the shortage of electric powe Canada caused by a drought.

Cellulose

Cellulose shipments in 1952 totaled 721,923 tons, a decre on 1951 of 259,620 tons or 26.5%. Exports of dissolving p registered a 15,918 ton rise, i.e., 30.5%. The quantity bleached sulphite exported was down 38,689 tons or 29. from 1951. For unbleached sulphite the fall was 94,446 t or 23% and for sulphate 142,402 tons or 36.7%. The lar buyers in 1952 were England 288,071 tons (422,905 ton 1951), the United States 126,378 tons (147,553 tons), Fra 67,035 tons (104,214 tons), and Western Germany 39,148 t (64,004 tons).

Because of the pronounced price drop the value of cell exports in 1952 was 33.5 thousand million or only a 58.9% of the 1951 level.

Whereas in 1951 the mills worked at approximately 97% of their capacity, in 1952 a little over 80% of capa was utilized for sulphite production and only 70% for phate. Thus there was a contraction of the order of 230, tons or 16.6% from 1951.

Board

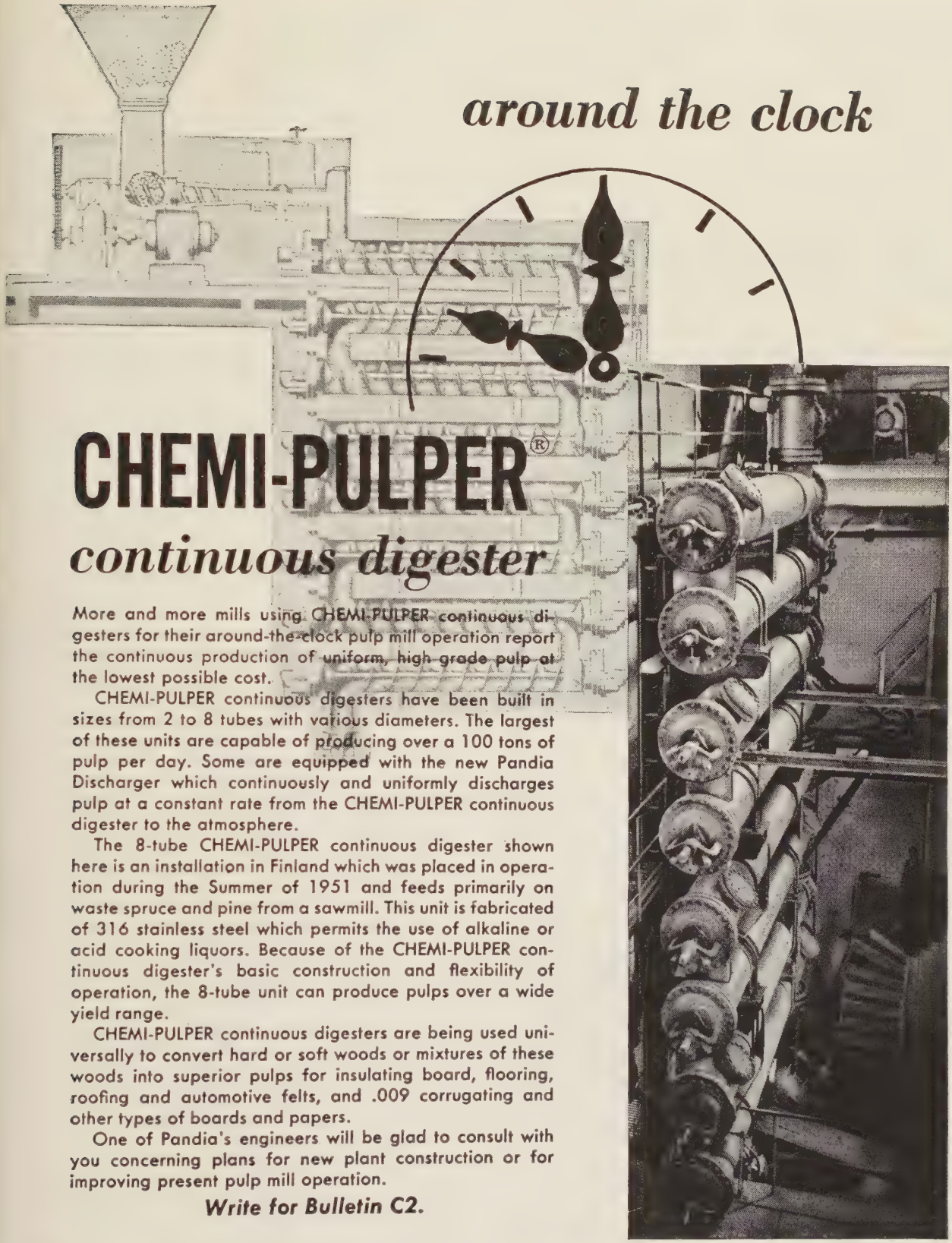
Board exports, including kraftliner, came to no more t 83,543 tons in 1952, i.e., 41.5% below the 1951 figure, 142, tons. Exports to the U.K. contracted specifically, tota 13,545 tons (52,255 tons in 1951). Exports to Western G many accounted for 17,054 tons (23,116), to Denmark 8 tons (14,224) and to the U.S.A. 7826 tons (5202).

The C.I.F. value of exports was 3800 million marks aga 8700 million in 1951. The decrease thus was 56.3%. B production contracted in 1951 from 204,612 tons to 147, i.e., 28.1%. Domestic sales totaled 15,521 tons. This s figure does not include board used by companies for t own processing activity.

Paper

Newsprint exports rose somewhat, according to cust statistics, compared with 1951, i.e., from 382,444 ton 392,442 tons or 2.6%. Deliveries of paper other than n print through the Finnish Paper Mills Association amou to 139,144 tons, 70,105 tons of it wrapping paper. In the corresponding figures were 164,880 and 75,609 tons the contraction in this paper group was consequently 15 (7.28% for wrapping paper). The corresponding ex

around the clock



CHEMI-PULPER®

continuous digester

More and more mills using CHEMI-PULPER continuous digesters for their around-the-clock pulp mill operation report the continuous production of uniform, high grade pulp at the lowest possible cost.

CHEMI-PULPER continuous digesters have been built in sizes from 2 to 8 tubes with various diameters. The largest of these units are capable of producing over a 100 tons of pulp per day. Some are equipped with the new Pandia Discharger which continuously and uniformly discharges pulp at a constant rate from the CHEMI-PULPER continuous digester to the atmosphere.

The 8-tube CHEMI-PULPER continuous digester shown here is an installation in Finland which was placed in operation during the Summer of 1951 and feeds primarily on waste spruce and pine from a sawmill. This unit is fabricated of 316 stainless steel which permits the use of alkaline or acid cooking liquors. Because of the CHEMI-PULPER continuous digester's basic construction and flexibility of operation, the 8-tube unit can produce pulps over a wide yield range.

CHEMI-PULPER continuous digesters are being used universally to convert hard or soft woods or mixtures of these woods into superior pulps for insulating board, flooring, roofing and automotive felts, and .009 corrugating and other types of boards and papers.

One of Pandia's engineers will be glad to consult with you concerning plans for new plant construction or for improving present pulp mill operation.

Write for Bulletin C2.

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THE ALEXANDER FLECK LIMITED, OTTAWA, CANADA.

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PANDIA INC.

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figures from the customs statistics for 1952 were 155,436 tons for paper other than newsprint (169,000 in 1951) of which wrapping paper accounted for 77,050 tons (78,905 in 1951). The contraction in customs statistics was thus 8.2% (2.4% for wrapping paper). The largest paper buyers were the United States 150,409 tons (149,311 in 1951), the United Kingdom 83,306 tons (86,827), Argentina 53,638 (70,017), Denmark 30,846 (39,247), Brazil 31,395 tons (28,768), the Soviet Union 23,816 tons (852), France 17,043 tons (12,695), Germany 22,321 tons (15,444), China 17,569 tons (4119) and Australia 12,324 tons (27,589).

Newsprint exports totaled 14.1 thousand million marks in value—13.9 thousand million in 1951. Exports of other paper than newsprint declined in terms of marks from 12 thousand million marks to 10.9 thousand million and the fall for paper exports as a whole was 3.5%.

Apart from newsprint, the production of which increased 21,986 tons (5.3%) in 1952 in comparison with the preceding year, paper production has diminished. Lacking orders, output remained at 246,169 tons, i.e., 22,709 tons and 8.5% below the 1951 level.

Newsprint and other paper sold in domestic markets in 1952 amounted to 86,968 tons.

Sweden

The market for Swedish wood products settled down into a state of comparative stability during the second semester of 1952 following six months of an unmitigated recession. The recovery was greater in the sawmill than in the pulp and paper industries but for the latter the volume of sales and average price quotations approximated by the end of the year the corresponding seasonal levels in 1949 and 1950.

"Since October the shipments of Swedish cellulose to the United States have amounted to between 20,000 and 40,000 a month and some observers think it not unlikely that Swedish cellulose exports to America in 1953 may rise between 300,000 and 400,000 metric tons." Such a figure would be double the total in 1952, but is considered by several industry leaders as the target which should and can be attained. In 1950 a total of 310,659 metric tons of chemical pulp was shipped to the United States.

According to the press, Sweden's share in the United States imports of wood pulp dropped from 16.6% in 1950 to 9.8% in 1952 while the portion from Finland declined only from 8.6 to 7.5 and that from Norway from 1.3 to 1.1%. During the same period Canada accounted for 71.9% of American pulp imports in 1950 and 81.4% two years later.

The dollar revenues earned by Sweden through wood pulp sales to the United States explains the official Swedish interest in regaining some of the dollar market lost by the industry's pricing policy in 1951–52. It is estimated that these Swedish pulp exports yielded approximately $37,000,000 in 1950, $43,344,000 in 1951, and $25,902,000 in 1952. The increase in 1951 is the result of the sharp rise in prices which counterbalanced the severe drop in volume. The drop of 47% in dollar earnings to that market in one year is deemed too large to be allowed to recur if any solution can be found. However, the Swedish government has not yet created any tangible incentives to step up pulp exports to dollar markets and only the decline in European pulp prices is inducing Swedish producers to take a new hard look at the possibilities of earning dollars.

Various industry sources predict that pulp prices are now at the end of a long downward trend and will stabilize at approximately the present levels.

The desirability for Sweden of curtailing pulp production until stocks have returned to normal and foreign demand increases has been the subject of considerable speculation in the press and several meetings of producers associations.

Two or more meetings have reportedly been held in the Stockholm offices of the Swedish Cellulose Association since the turn of the year allegedly with the aim of reaching agreement on curtailing production to 90% of the 1951 level. In the case of Sweden this would mean an annual production for export not to exceed 1,760,000 in 1953, closely approximating the corresponding figure for 1952. Such a move, if implemented, might not only raise European pulp prices, it would also restrict Sweden's earnings of dollar and soft currencies and might therefore be blocked by the Scandinavian governments affected. Several sources in the pulp industry have confirmed that deliberations are under way aimed at a concerted reduction in output. A very convincing case is made from the fact that pulp inventories at the Swedish mills of almost 300 000 metric tons before the close of the shipping season in the Bothnian Gulf is excessively high. The sheer mass of stocks available for immediate delivery is felt to have a depressing effect on the pulp market which could continue or accentuate last year's depression in sales.

The unwieldy volume of pulp stocks on hand last Autumn has been somewhat alleviated by unseasonably large export shipments from November through January. The export of 208,000 metric tons of mechanical and chemical pulp in January, 1953, is unprecedented at that season and was made possible by mild weather and the prevailing westerly winds which reopened the main ports on the west coast of the Bothnian Gulf. During February, the stocks did not increase much because exports through Stockholm and Gothenberg were accelerated despite the adverse rail freight differential to the buyers.

The developments in the Swedish paper industry during the second half of 1952 have been far less hopeful than those in the pulp industry. The steady decline in prices and foreign demand, only slightly less pronounced in the Autumn than in the preceding Spring has not yet responded to the slight curtailment in Swedish paper production. The outlook of the industry at the turn of the year remained somewhat depressed.

In general, the market prospects for Swedish forest products in 1953 were cautiously optimistic. The lumber, pulp, and paper industries had been shaken by the sudden sharp slump in the middle of 1952 and overconfidence had vanished. A new realization that Sweden could no longer dictate pulp and paper prices has permeated all segments of the industry following a belated respect for the potential exportable surplus in North America and for the ability of sterling countries to ration their needs to fit their purse.

The need to re-develop a pulp and newsprint market in the United States was now appreciated by Swedish officials and industry representatives but the means to do so have not yet been found. Outright subsidization has been ruled out by the fear of incurring the penalties of the Anti-Dumping clause in the American Tariff Act as well as the threat of invoking protests and reprisals in Britain and Benelux. This dilemma was increased by the abrogation of the so-called "export fees" early in 1952 since by specifically exempting sales to the United States from this levy such sales had been favored. But such assistance had no apparent effect in increasing sales to dollar areas.

The current activity and long-forgotten sales efforts in all Swedish wood industries was buoyed by the hope—bordering on conviction—that in the long run production costs in North America "should" rise more rapidly than under the semicontrolled economy of Sweden and the world demand for paper and lumber will grow indefinitely.

Many Swedish sources seem in agreement that production, sales, and prices during 1953 are likely to be stabilized at the year-end (December, 1952) levels, and such a prospect implies a state of prosperity which has only been exceeded in recent times by the glittering Swedish boom of 1951.

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You'll find that "Elvanol" adheres well to fiber surfaces—forms tough bonds and produces surfaces which are non-blocking.

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An economical water-dispersed, high-solids resin, easily applied by standard coating methods. Provides tough, strong, grease-resistant coatings for bakery cartons and food containers, such as cartons for shortening, candy and nuts. Coatings can be heat-sealed to greaseproof cartons, pouches, bags can be made without adhesive. Also useful in strengthening and stiffening papers and paperboard.

The coupon below will bring you full information about "Elvanol" and "Elvacet" and how they can be used in paper. E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

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I would like to know more about____"Elvanol"____"Elvacet" as used in the paper industry. I am specifically interested in its advantages for use in_____

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paper, paperboard, and paper products for 1952 and 1951, as reported in the monthly FT 110 reports of the Bureau of the Census for 1952 and 1951 is as follows:

	1952[a]	1951	Per cent change
Total	$924,974,007	$953,333,215	− 3
Pulpwood	46,986,543	45,406,655	+ 4
Wood pulp	271,081,358	351,064,355	−23
Rags, bags, grasses, etc.	7,005,489	12,230,545	−43
Paper	581,662,936[b]	525,157,804[c]	+11
Paperboard	10,020,281	12,675,223	−21
Paper products	8,217,400	6,798,633	+21

[a] Preliminary.
[b] Includes newsprint at $571,438,651.
[c] Includes newsprint at $513,813,327.

France

Three new pulp mills are projected for France. One of these will manufacture 25 to 30,000 metric tons of wood pulp from esparto grass and is expected to be in production in 1955. Another mill will make wood pulp from eucalyptus wood with an annual capacity of 20,000 tons. Manufacturing is expected to start also in 1955. The third mill with a capacity of 35,000 tons annually will manufacture wood pulp from a species of short fibered wood. This mill is expected to go into operation this year (source—*Swedish Timber & Wood Pulp Journal*, March 15, 1953).

Tunisia

A British-French finance group is planning the construction of a wood pulp and paper mill in Tunisia using esparto grass as a raw material. Annual capacity is to be 60,000 tons. The mill is expected to cost about $3,000,000 and will commence operations in the Fall of 1954.

Bears

For the past four years, bears have been causing an ever-increasing amount of damage to young fir trees in western Washington and the Olympic Peninsula. Attacking the cambium, or growing layer, of the tree, the bear tears off the bark until the sapwood is exposed completely around the tree. This is known as girdling, and the result is a dead tree.

In some locations tree mortality has run as high as 75 to 80% of a stand. Last spring a team of biologists and hunters was assigned to an area covering 30,000 acres south of Grisdale forest community to determine why bears are annoying trees.

Simpson Logging Co. and the South Olympic Tree Farm cooperated with the Washington State Game Dept., the U. S. Fish and Wildlife Service and state biologists on the bear control project. Simpson furnished the land and the bears; and agencies directing the work furnished the hunters, dogs, traps, and experience.

On the recommendation of the Puget Sound section, Society of American Foresters, the state placed black bear on the list of predators and, with that for a starter, the problem resolved itself into one of securing enough bears for stomach analyses to be made.

Log Handling Safety

"In the Clear," a job training booklet that shows the safe way to handle logs, has just been published by the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., in cooperation with British Columbia Forest Products, Ltd. The eight-page two-color booklet singles out the "chance taker" as the villain in the logging accident picture.

Safety rules covering the principal hazards of the industry are presented in easy-to-understand copy illustrated with humorous cartoons. The booklet shows the safe way to handle axes and saws and set chokers. Helpful hints on lifting heavy objects and working around machinery are included. With slips and falls accounting for most of the accidental injuries to loggers, "In the Clear" stresses the need for good boots and other protective clothing.

Forest Products Laboratory

Talents and research brains of many countries are contributing to progress at the U. S. Forest Products Laboratory here these days as foreign collaborators participate in actual investigations, from sawmilling to by-product developments.

Eight collaborators from Asia, Europe, and South America are at work on a variety of research projects. They include seasoning, wood preservative treatments, veneer and plywood production, wood identification work, pulp and paper production methods, and manufacture of wallboard from wood milling residues.

Conferring with J. A. Hall of the U. S. Forest Products Laboratory here are eight foreign collaborators now doing research at the laboratory to get training in scientific methods. Standing with Mr. Hall, from left, are: Ying-Pe Chang, China; Sixto Jose Pericchi, Venezuela; Thanom Premrasami, Thailand; and Qudrat Ghani, Pakistan. Seated, from left, are: Takeo Ogura, Japan; K. Ganesan, Ceylon; Chern Nilviset, Thailand, and Friedrich Aflenser, Austria

Some are financed by their own governments. Others are beneficiaries of the Point Four Program, Fulbright scholarships, and Mutual Security Agency programs for getting technical know-how to undeveloped countries or aiding in the cold war against Communism. And still others represent private companies and trade organizations of their homelands.

One, Ying-Pe Chang, is a stranded Chinese student with a Ph.D. from the University of Michigan, now doing research financed by the Technical Association of the Pulp and Paper Industry of this country. He came to the United States about 6 years ago from the National Research Institute at Shanghai. That was before the Nationalist government of Chiang Kai-shek retreated from the Chinese mainland.

I.P.

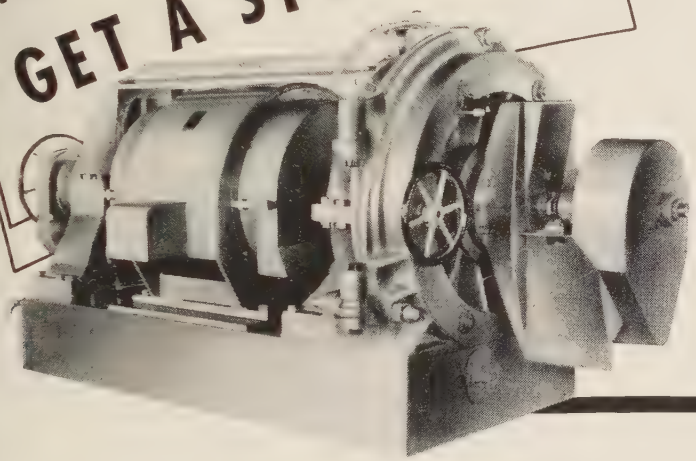
The only major expansion work of the International Paper Co. in 1952 was in connection with the second unit at the Natchez, Miss., dissolving pulp mill where a construction program designed to double the mill's capacity was authorized in 1951. Practically all other capital expenditures made during 1952 at the paper mills and converting plants of the companies consisted of improvements and additions to existing equipment. While such expenditures were directed primarily toward achieving greater operating efficiency and better quality product, they had the further effect of increasing annual productive capacity of the companies' paper, board, and pulp mills by approximately 71,000 tons (including 14,000 tons yearly of additional Canadian newsprint capacity). This raised the total annual mill capacity of the companies to 4,004,000 tons as of Dec. 31, 1952.

Q. *What's the biggest name in pulp refining?*

A. "SPROUT"

for that pulping problem—
GET A SPROUT!

here's why:



Sprout-Waldron Refiners are chosen by *most* mills for all types of pulping and refining operations. They are the *leading producers* of semi-chemical pulp. For economical pulping and refining, choose a Sprout!

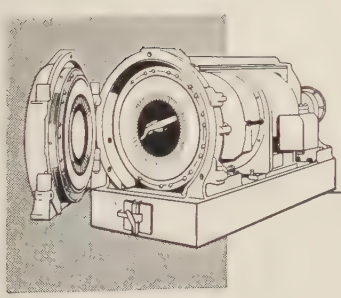
* high pulp quality
* high capacity
* flexible operation
* rugged construction

Is this Your Refining Problem?

- SEMI-CHEMICAL PULPING, unbleached and bleachable pulps, all grades from corrugating board to newsprint and bond paper
- High Yield Kraft Pulping (Brown Stock Refining)
- Kraft and Sulphite Knotter and Fine Screen Rejects
- Groundwood Screen Rejects
- Bagasse and Straw Pulping, for unbleached and bleachable pulps.
- Insulation Board Fiber Preparation
- Hardboard Fiber Preparation
- Flooring Felt Fiber Preparation
- Waste Paper Stock Preparation

For careful analysis and specific recommendations, send your pulping problems to Sprout-Waldron. Address: Sprout-Waldron & Co., Inc., 38 Logan St., Muncy, Pa.

S W



SPROUT-WALDRON

PULP REFINERS

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91 A

Work on the Natchez Mill extension and improvements at the existing unit have proceeded on schedule except for some delays due to inability to obtain equipment on time. Production at the existing unit has been increased from the 300 tons of dissolving pulp originally planned to 450 tons per day. The new unit which started operations early in March, 1953, has a similar capacity, bringing total capacity of the mill up to 900 tons per day of dissolving pulp.

The reconstruction program at the Hawkesbury dissolving pulp mill of Canadian International Paper Co. was substantially completed by the end of 1952 and the mill is now producing some of the special new grades of hardwood dissolving pulp developed at the adjacent laboratories of that company's wholly owned subsidiary, Industrial Cellulose Research Ltd.

St. Regis

Top officials of St. Regis Paper Co. and a group of guests representing insurance, banking, and business firms and representatives from public life, toured the southern properties of the company March 9 through 14.

The tour included an inspection and formal opening of the new St. Regis kraft pulp, paper, and board mill at Jacksonville, Fla.; a visit to the Suwannee Forest tract in southern Georgia, one of the major sources of supply for the Jacksonville mill; and an inspection of the company's expanded "Kraft Center" at Pensacola, Fla.

In his speech on March 10, at the dinner marking the formal opening of the Jacksonville mill, Roy K. Ferguson, president and chairman of the board of St. Regis, said: "Our move into Jacksonville and the start of operations of our pulp and paper mill represent an important milestone in St. Regis' history. It is our sincere hope that we may, in every sense of the word, be deemed worthy citizens of your community and contribute to its social and economic life."

Mr. Ferguson traced the growth of the southern pulp and paper industry and pointed out that of the 560,000 tons of present annual kraft capacity of St. Regis, 365,000 tons are in Florida mills.

"This mill (at Jacksonville)," Mr. Ferguson said," is the first major integrated mill that the present management of St. Regis has built from the ground up. Mergers, acquisitions, expansion, and modifications have been carried on by St. Regis in other plant locations. However, at Jacksonville, we selected the site and planned and constructed a modern paper mill. Our design provides for substantial expansion as the demand for our product increases."

The abundant water supply, completely integrated transportation facilities, productive labor force, and access to nearby woodlands, were among the factors which brought St. Regis to Jacksonville, Mr. Ferguson stated. He added that St. Regis "brings to your community a national manufacturing organization, with affiliated operations in Canada, Europe, and South America, and more than 50 years of papermaking experience.

"The directors of St. Regis approved the expenditure of many millions of dollars on our Jacksonville mill. Approximately one million dollars of this has been spent on special facilities. A substantial portion of this money has been spent on the construction of electronic precipitators. These are designed to eliminate, as far as it is technically feasible today, smoke and odors from kraft mill operation. The balance of this special expenditure has been in the construction of an outlet which insures distribution of mill effluent at deep levels of the harbor water. This is designed to furnish maximum safeguard for marine life and to protect against water pollution."

Sulphite Research League

The present status of Sulphite Pulp Manufacturers' Research League, Inc., research program is given below:

1. Whole Liquor Research

(a) *Roadbinder.* Eleven mills now have experimental o full-scale roadbinder programs operating. Approximately 30,000,000 gal. of roadbinder were used in Wisconsin alone during 1952, and most of these mills will use more liquor fo this purpose during 1953. Total gallonage used on road this coming year probably will increase.

The research grant at University of Wyoming is studying use of spent sulphite liquor on asphalt, with particular em phasis on treating old and new asphalt roads, to obtain au thentic technical data to check upon empirical results of high way engineers and contractors.

(b) *Evaporation.* Two processes under test in League pilo plant. One has already proved practical; the other is stil being tested, with predominantly favorable results to date Two mills have evaporator plants now operating, another ha evaporator being installed. Concentrated liquor originatin in member mills is going to users for purposes ranging fro adhesives to chemical raw materials.

(c) *Burning.* One mill has a furnace designed to burn onl concentrated spent sulphite liquor, and is burning practicall all that it evaporates—with sales to outside consumers whe these appear advantageous. Another is selling large fraction of its evaporator output and burns all the unsold concentrat over a coal bed.

Tests have been conducted at three other mills, using liquo concentrated in the League's pilot evaporator. One of thes mills has re-built a furnace especially designed to burn liquo and has proved this in a test run.

(d) *Briquetting.* Research grant in effect at University o Wyoming. Development work is continuing with leadin manufacturers of briquetting machinery and with the coa trade. Two successful coal processes have been developed and one company is currently equipping to utilize one of thes processes in full-scale operation. Experiments are bein continued with various ores.

(e) *Miscellaneous*

(1) *Agricultural Uses.* League tests have been inconclu sive. Small-scale studies, without League financial suppor are being carried on at University of Wisconsin and at Mich gan State College.

(2) *Adhesives.* Explorations under way. Following tes of concentrated liquor from League pilot plant, commerci manufacturers of adhesives are currently using concentrate liquor originating with member mills.

(3) *Dispersants.* Most of the work in this field has bee carried on by a member mill that makes these products fo commercial use in several industries. It is supplementin its own mill's output of spent sulphite liquor with concen trate obtained from another member mill's evaporator plan

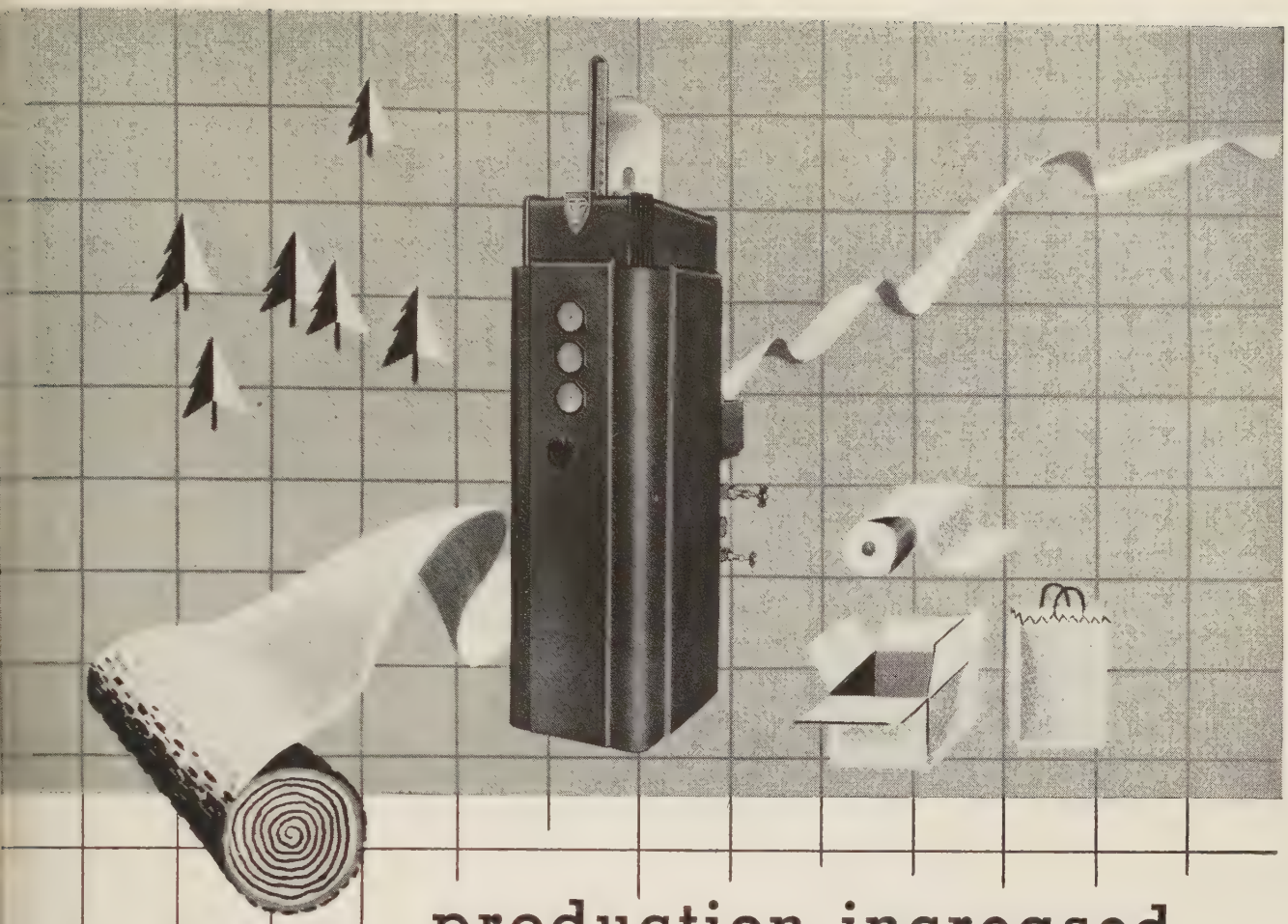
2. Sugar Fraction Research

(a) *Torula Yeast Process.* Originally developed in Leagu laboratories and pilot plant. Development work on th method of using sugars now goes on at Rhinelander plan with controls and further research in League laboratorie Technically proved, commercially promising. More tha 50,000,000 gal. of spent liquor were thus processed in 195 One member mill at Green Bay started construction of mil scale yeast plant in March, 1953.

(1) *Feed Supplement.* University research projects nanced by League now under way at Wisconsin, Minnesot Michigan State, and Iowa State. Animal and poultry fe manufacturers are the basic big-volume market for toru yeast.

(2) *Human Nutrition.* Rhinelander plant now meeti highest technical standards for human food and pharmace tical uses. Plant now under construction at Green Bay h been designed to highest standards. This market is bei explored. Small but desirable market potential.

(3) *Raw Material for Chemical Processing.* Specialist co



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

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I-42

sultants have been used in this new field. The material is under experiment by chemical and pharmaceutical manufacturers both as a nutrient in biochemical processes and as a source of organic chemical raw material.

(*b*) *Other Fermentation Processes.* Theoretically it is possible to use other types of organisms causing fermentation than *Torulopsis utilis* to consume the sugars in spent sulphite liquor. Different fermentations yield end products as different as fuel gases, plastic intermediates, and synthetic rubber ingredients. Work is being done along the more promising lines.

(c) *Basis Research on Sugars.* Industry's greatest technical advances usually follow basic studies that have no immediate commercial goal. We need to know more about the nature and behavior of wood sugars before we can deal with them most effectively. Such a long-range project is now in its second year under the direction of a sugar chemist.

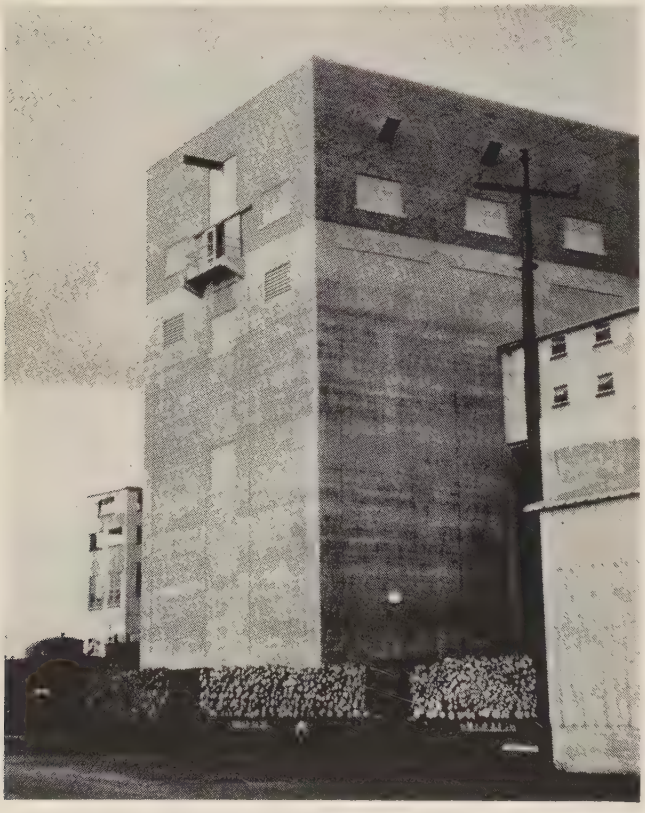
3. Lignin Fraction Research

(a) *Chemical Derivatives.* From lignin the organic chemist can derive many other products. The Institute of Paper Chemistry handles the lignin research. Vanillic acid derivatives have been clinically tested by several medical research groups with promising results in treating some diseases that are usually fatal.

(b) *Insolubilization.* Lignin has excellent adhesive qualities, but because it is soluble in water has a narrower potential market than if it were water resistant. To render lignin insoluble in water without decreasing its adhesive qualities is a major objective of this study.

Hollingsworth & Whitney

A new bleach plant, the first where the building as well as the bleaching towers were built by the sliding form method of concrete construction, has been completed at the Hollingsworth & Whitney Co. paper mill in Mobile, Ala., according to The Rust Engineering Co., the designer-construction.



Oblique view of the new bleach plant building at Hollingsworth & Whitney's Mobile, Ala., paper mill

The new unit undertaken in Hollingsworth & Whitney's modernization and expansion program, will increase the mill's existing bleach stock capacity by 150 tons per day.

The six-story bleach building was poured by the sliding form method in ten days, including columns and nine bleaching towers which went up with the walls.

The building was literally hauled up by its own screwjacks in a continuous lift operation. Rust engineers estimate the sliding form method is nearly ten times faster than similar construction with fixed or so-called movable forms.

In this method of construction, 1-in. rods of special alloy steel are set vertically among the reinforcing rods in the concrete at intervals. A screwjack mounted on a yoke climbs each special jack rod by means of dogs. As the screwjack is turned it pulls up the yoke which hauls up an attached wooden form and working platform.

Rate of climb depends on the rate the concrete sets, slower on a cool wet day, and fast on a hot dry day. The 20-ft. jack rods are continuously extended by a pipe sleeve arrangement as the walls go up. Height of the rods is carefully staggered for strength and continuous operation.

The extent of this type construction at the new Hollingsworth & Whitney bleach plant may be judged from the height of the walls which were $77^1/_4$ ft. The nine bleaching towers themselves averaged 14 ft. in diameter and 60 ft. high. They reach to the operating floor on the top level of the building.

The operating floor has an exterior brick wall with glass block windows and contains the bleach plant controls and the laboratory. Consistency of the paper stock and temperature of the wash water are automatically controlled from this floor. Manual controls located here can regulate flow of the stock and adjust flow of the different chemical solutions used in the bleaching process.

In the process used, the Kamyr continuous bleaching system, the brown stock entering the building goes through the bleaching towers where it is subjected to chlorine, caustic and other chemicals to take out the color.

Bleached stock is used in making high-grade paper as against the unbleached kraft paper which retains the brown color and is used for wrapping paper, paper bags, and the like.

Two 30-ft. diameter by $46^1/_2$-ft. high concrete storage tanks for bleached stock were also constructed by the sliding form method and adjoin four previously constructed storage tanks outside the bleach plant.

Champion-International

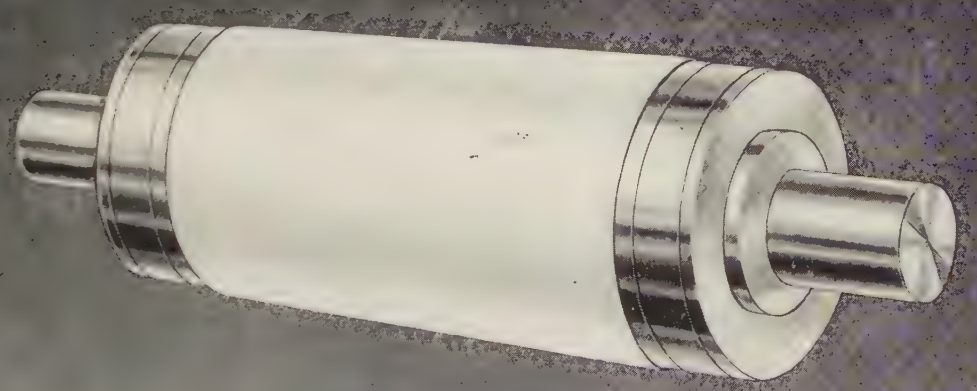
Champion-International unveiled a new debarker at a special demonstration held recently at the company's woods yard operations at Bow, N. H. Members of the Northeastern Technical Committee of the American Pulpwood Assn. and visitors from Canada watched the new machine, an Anderson debarker, operate. It is the second machine of its type in the United States and first to be used by a paper manufacturer. Champion-International recently moved its woodlands office from Lawrence, Mass., to Concord. The company uses hardwoods exclusively, and its installation of the debarker unit is another significant step forward in the development of a wood purchasing program to stimulate wise woodland management in southern New Hampshire and northern Massachusetts.

Rhinelander

Rhinelander Paper Co. is celebrating its 50th anniversary this year. During the half-century, the company has grown from a two-machine mill, manufacturing newsprint and wrapping papers, to an eight-machine mill which makes a complete line of glassine and greaseproof papers.

Rhinelander is the largest mill under one roof in the state of Wisconsin and the largest in the U. S. producing glassine and greaseproof papers, company officials state.

"HOLYOKE" CALENDER ROLLS



HOLYOKE MACHINE COMPANY

CALENDER ROLLS for the PAPER and TEXTILE INDUSTRIES
WATER FILTRATION EQUIPMENT
HOLYOKE, MASSACHUSETTS

Great Northern

The Department of Industrial Cooperation at the University of Maine announced recently that the Great Northern Paper Co., one of Maine's largest industries, has donated $5000 to create two industrial research fellowships.

These fellowships make possible substantial financial assistance for graduate students engaged in advanced programs of research under the direction of members of the university staff. The nature of the projects is fundamental research and is determined jointly by the university staff and donor. The projects are not confidential in that the theses or abstracts will be made available to the industry at large by publication of the final theses or abstracts in some recognized journal.

Union Bag

A new type of electrostatic precipitator, which uses a wet-bottom flow method instead of a dry hopper and conveyor system for handling collected dust, has been installed at the Savannah, Ga., plant of Union Bag & Paper Corp. Other precipitators used by Union Bag are dry hopper types. The new wet-bottom precipitator is the first of its type installed at the Savannah plant.

A wet-bottom precipitator eliminates cost of auxiliary equipment required with a dry hopper. It also speeds return of collected material to the pulp making process. The wet-bottom precipitator was recently designed by Research Corp. of Bound Brook, N. J., manufacturer of Cottrell precipitators.

The new precipitator at the Savannah mill will remove sodium sulphate from a spray-type black liquor recovery furnace handling 1,050,000 lb. of black liquor solids daily. The precipitator will clean 160,000 c.f.m. of gas at 275 to 300°F. with a rated efficiency of 90%.

Five precipitators of the dry hopper type were originally placed in operation to handle gases from nine recovery furnaces. These furnaces treat a total of 3,240,000 lb. of black liquor solids per day at full load, representing a pulp production of 1200 tons per day.

A sixth precipitator completed in 1950 and the new wet-bottom precipitator will clean gases from two spray-type recovery furnaces handling a total of over 2,000,000 lb. of black liquid solids per day, equivalent to a daily pulp production of 700 tons. All seven precipitators built by Research Corp., will handle a combined volume of over 875,000 c.f.m. of gas on full load at about 275 to 300°F. with 90% rated efficiency.

Paterson Parchment

E. R. Leonhard was elected President of the Paterson Parchment Paper Co., Bristol, Pa. Mr. Leonhard joined the company in 1920 as a member of the accounting department. Since 1938 he was Vice-President in Charge of Sales.

E. R. Leonhard, Paterson Parchment Paper Co.

Atomic Bomb Protection

Civil Defense experts in London are studying a proposal to wrap London's important buildings in brown paper should an atomic attack appear imminent.

A spokesman stated that a heavy paper screen around a building could save it from the instantaneous heat flash. Such a screen could be used on the more inflammable parts of buildings.

Zellcheming

The Verein der Zellstoff-und Papier Chemiker und-Ingenieure will meet at Bad Kissingen on July 14–17, 1953. This meeting will be followed by the Dusseldorf Exposition from July 18 to August 16.

University of Toronto

W. Howard Rapson has joined the chemical engineering staff of the University of Toronto as Professor. He will lead the research activities of the department in the field of pulp and paper. During the past 12 years he has been a member of the staff of the Canadian International Paper Co. and Industrial Cellulose Research Ltd. at Hawkesbury, Ont.

Foremen's Salaries

National Foremen's Institute, New London, Conn., has issued an interesting booklet, "A Pilot Survey of Foremen's Salaries."

Scottisue

Scott Paper Co., Chester, Pa., has awarded the construction contract for its new mill at Everett, Wash., to Howard S. Wright Co. and the American Pile Driving Co. of Everett, Wash.

It is expected that paper mill operations will start early in 1954. At that time Scott plans to manufacture part of its line of household paper products at their integrated operation at Everett.

L. S. Burdon, Assistant Vice-President, will supervise the activities of the company's Empire, Ore., and Anacortes, Wash. pulp mills, reporting to Paul Baldwin, chief administrator of Scott's West Coast operations.

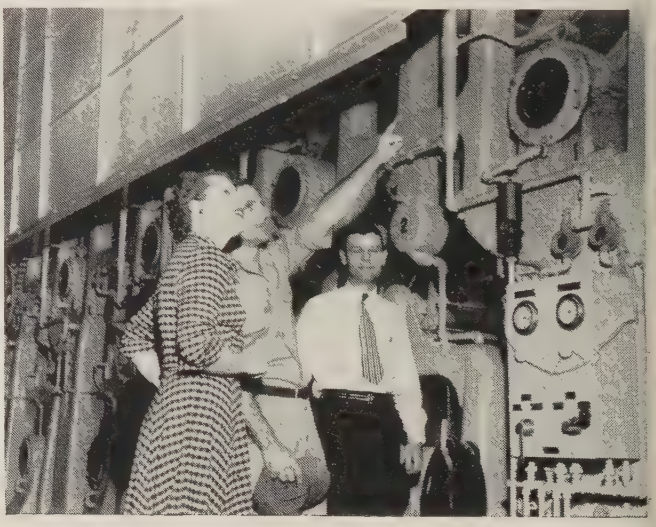
R. I. Thieme, Technical Director at the Soundview Div., has been named Plant Manager at the Anacortes mill.

L. V. Forman, staff utilization at Chester, has been made Technical Director of the company's West Coast mills with headquarters at Everett.

R. M. Heath has been Manager of pulp sales with headquarters at Chester.

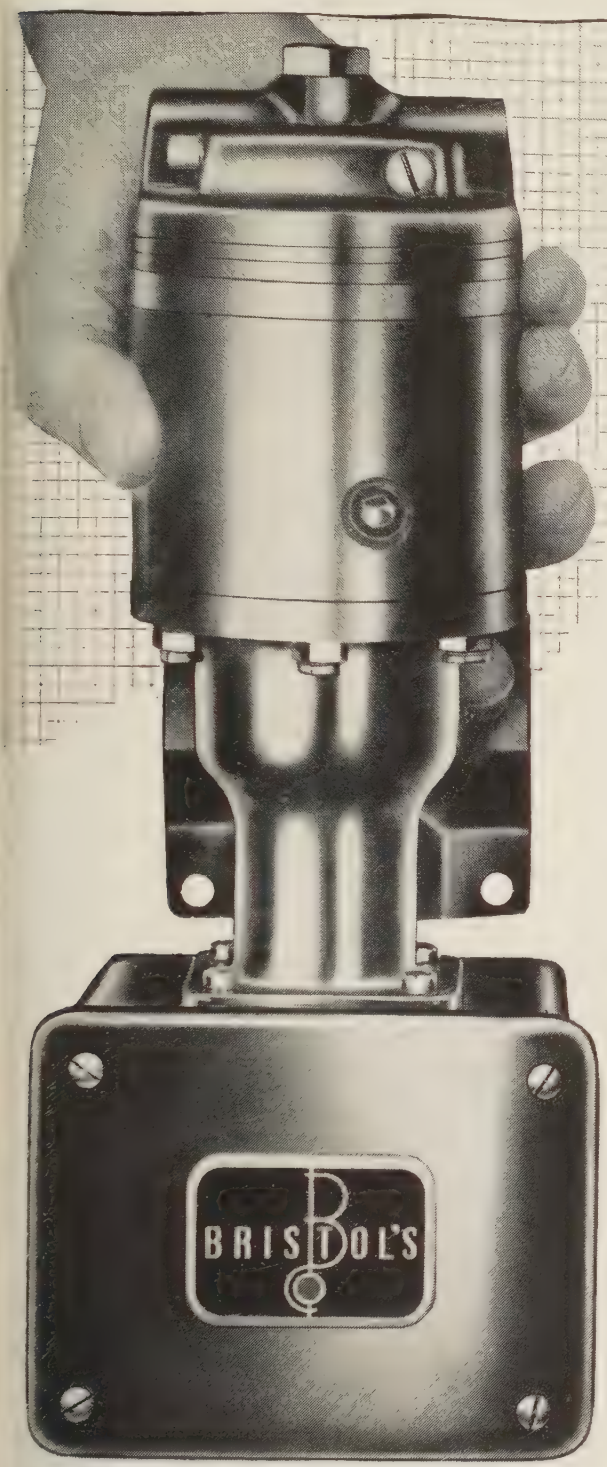
Scott's sales of finished paper in the first three months of 1953 totaled $37,522,006 and established a new high record for any quarterly period in the company's history. Thomas B. McCabe attributed the sharp increase to an increase in the size of the sales force, increased advertising, including the use of television, quality improvement, and the introduction of a paper napkin in 1952.

Scott utilized television on a national basis for the first time during 1952 with the launching of the Scott Music Hall which is telecast biweekly and stars Patti Page. Miss Page got a lesson in papermaking during a recent visit to the Ches-



George Wensel, machine tender, left, and A. J. Haug, paper mill superintendent explain the operations of a paper machine to Miss Patti Page

WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL



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● **SIMPLE TRANSMITTING MECHANISM—frictionless operation**—only one pivot and no flexures—will operate in any position—is weatherproof and can be installed in any location, pipe-saddle or surface mounting.

● **AVAILABLE IN A WIDE SELECTION OF RANGES:** Pressure (0 to 5″ water to 0-10,000 psi), vacuum (0 to 5″ water to full vacuum), temperature (−100° F. to 1000° F.), liquid level (0 to 5″ water and up), flow (mercury manometer, bell type, and Barton meter bodies), and differential pressure (0 to 2.0″ water to 0-500″ water). Suppressed ranges available. Over-range is standard, up to 500% for some ranges. Write for free bulletin No. A105. The Bristol Company, 102 Bristol Rd., Waterbury 20, Connecticut. 6.3.8.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

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ter plant. Miss Page was accompanied by her orchestra and gave a half-hour concert for the employees in the recreation room. The concert was carried over the public address system and was heard by 1800 employees throughout the plant.

Offset Plate

Remington Rand, Inc., 315 Fourth Ave., New York, N. Y., has entered the presensitized offset plate field with its new photospeed plastiplate that requires only one step after exposure to make the offset plate ready for the press (Booklet DS 108).

Gaylord

Gaylord Container Corp., Bogalusa, La., whose holdings in Louisiana and Mississippi are believed to constitute the largest privately owned man-planted forest in the world, during the planting season just closed, planted 18,630,000 seedlings on 24,770 acres. Through its forest management program Gaylord has assured itself of a perpetual supply of raw material. Planting cost ran 8 to 10 dollars per acre. About 80% of the planting was done by hand.

Gaylord has issued an interesting publication entitled, "H. H. Williams, Tree Farmer." It is the story of what is being done by one small Louisiana tree farmer.

Arkansas Forests

The Southern Forest Experiment Station, 2026 St. Charles Ave., New Orleans 13, La., has issued a bulletin on "Forest Statistics for Arkansas." The State's forests appear to be growing more timber than is being cut. About half the growth is pine and the other half is in hardwood.

Engineering School Enrollment

The almost unprecedented increase in the number of freshmen engineering students in 1952 (30.5%) has been exceeded only once, and that was in the year immediately following World War II. The 51,631 new students entering in the Fall of 1952 represent the third largest class ever to enter the engineering schools. Exceeded only in 1946 and 1947, the number of new engineering students account for 16% of all male students entering college for the first time in 1952.

Nekoosa-Edwards

A new fully automatic ream wrapper and labeling machine, the first of its kind in the country, has been developed by the Nekoosa-Edwards Paper Co., Port Edwards, Wis. At present one machine has been completed and is in regular operation in the finishing room, but three more machines are being built by Nekoosa Foundry. The machine will be sold by Griswold and Johns, 4458 Madison St., Chicago, Ill.

A scholarship awards plan has been announced by Nepco Foundation, Port Edwards, Wis. A minimum of four new awards will be made annually of $750 each. The awards will be reviewed yearly for three additional years provided the student's progress is approved by the awards committee. Eligibility is restricted to children of Nekoosa-Edwards Paper Co. employees, children of residents of Nekoosa and Port Edwards, and Nekoosa-Edwards employees.

A five-row full bed transplanting machine which can plant up to 85,000 young trees a day has been developed and is now in operation at the Nekoosa-Edwards nurseries.

Bench Marks

At the beginning of 1953 annual steel ingot capacity was 1483 lb. per capita, as compared with 1237 lb. in 1940 and 556 lb. in 1900.

"Back of our plants, back of the people who build and operate them, are our research laboratories, and they are perhaps our greatest single resource. Every new product, every improvement in process, every advance in technology, had its beginning somewhere, somehow, in the mind of a research worker in his laboratory. Research is the essential vitamin without which the body of industry loses its vitality and dynamic character," Crawford H. Greenwalt, President, E. I. du Pont de Nemours & Co., Inc.

The population of the United States, including armed forces overseas on February 1, 1953 was 158,657,000.

Crown Zellerbach

Edward P. Stamm has been made a Vice-President of the Crown Zellerbach Corp. He will be directly in charge of the corporation's timber, logging, and forestry operations in the United States, and will retain his headquarters at Portland, Ore. Mr. Stamm has been with the company for 27 years.

A Vanished Paper Mill: The Stratford

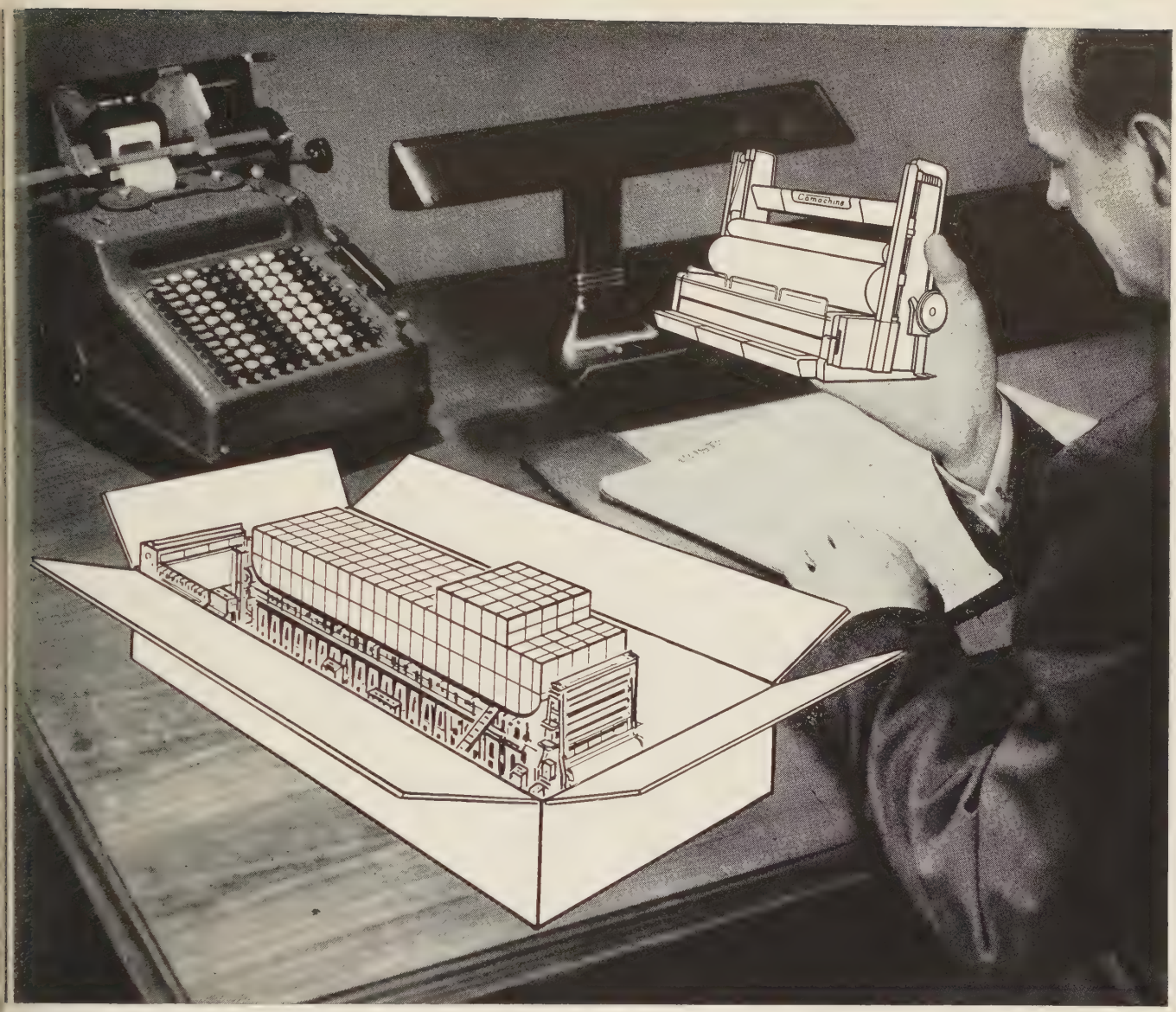
They speak of the ghost towns of California, those remains of a fabulous industry which, in relatively short periods of time, went from boom to oblivion. Gold mining produced those localities, but although spectacular it is not unique, for other industries including the paper industry have in their chapters of history many similar instances. Although not ghost towns, entire communities, once thriving centers of papermaking, today either no longer exist or have been totally converted to other industries. And the old paper mills? Unfortunately sometimes, not even traces remain.

There is such an instance in Ohio, in Stratford, Delaware County, about 18 miles north of Columbus, once a busy papermaking village. As did so many others, the mill there began its existence as a grist mill in 1808, was enlarged and partially rebuilt in 1829. First mention of it as a "papermaking establishment" is found in a recorded deed of Aug. 15, 1832, when it was sold to F. Meeker for $4000.

The Stratford mill had a long history. It changed hands many times and burned twice but was recognized as the most important paper mill west of the Alleghenies by 1840. Production then consisted of printing, book, and wrapping papers. A record of 1872 shows that two cylinder machines of 52 and 48 in. were in operation making news, tea-wrapper, tissue, book, and wrapping. A 60-in. Black-Clawson fourdrinier was installed in 1884, and another 48-in. fourdrinier in 1885. These machines were changed back to cylinder in 1894 making 8 tons of straw-wrapper per day.

Competition and economic conditions pressed hard on the owners of this mill and about the turn of the century it closed permanently. The real estate sold for $2000 and in 1900, the two machines were sold and moved to Brownstown, Ind., where the Kieffer Paper Co. still exists today. In 1902 the Columbus, Delaware, and Marion Electric R.R. Co. bought the Stratford mill property and converted the buildings to a carbarn and repair shops—a truly inglorious end for a paper mill. Fate, however, intervened when on Dec. 15, 1927, the building burned and was never rebuilt.

There remains only to tell of a witness's account of some of the conditions at this mill. One such account was chosen as being typical: It was discovered in an old publication, "Superior Facts." We quote Edw. Howard (a famous old papermaker) who tells about the time the Hill brothers operated the mill: "The machine was one of the first cylinders, had six driers, making 2400 lb. per day. The other machine was a relic of the Middle Ages, handmade, built up of scraps, odds, and ends. It was tied up and wired from stem to stern. When I arrived, they were making news entirely of rags, nice clean country rags, with 40 to 60 girls in the rag room. If they had stuck to writing or tissue it would not have been so bad, but to use such stock for print was a crime. But what could you expect, there was no modern papermaker in sight. Stock was bleached with powder, not with liquid, colored white with ultramarine measured with a tin cup instead of being weighed. Rosin was put into the beater in paste form. The paper was hard and strong, it should have been since it was made by strong, hardboiled people. That Stratford was a hard joint at the time. Frank Hill was a gentleman farmer,



WHAT IS THE COST OF THE WINDER?

It is sometimes expedient to purchase a winder as part of an overall paper mill "package". Even so, there's no need to wind up with less than a Camachine . . .

Camachine winders may be purchased for use with any new or existing paper machine. Study Camachine's rugged, dependable design—compare production records — compare the fine quality of Camachine-made rolls — and you'll find that a Camachine *adds no extra cost* to the package!

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knew nothing about papermaking, and they put a teamster on to run one machine."

Nothing remains and it may be forgotten by most, yet nevertheless, it was important, for this mill provided a training ground for many a young man who later became a skilled papermaker in the Miami Valley.

Ernest F. Barker
Oxford Miami Paper Co.

A Night on Number Three

The annual banquet of the Paper Makers of the St. Croix Paper Co. held in Woodland, Me., in January was featured by an original poem by Sam Gagner "A Night on Number Three."

Of all the time I've put in here
One night I won't forget
The night the world seemed upside down
With paper running wet.

Everything was running well
Just like a brand new tire,
When someone dropped a slab of broke
Upon the brand new wire.

I was out to get a lunch,
My back I couldn't bend,
When I got back I laughed to death
To see Mike Helfen cut an end.

That's the night we'll all remember
'Cause "Smokey's" daughter was born
Which didn't help poor Tuliff none
Because his stack was gone.

Tuliff was setting slitters,
And Bailey was making reels,
Wahl was trucking rolls out
With Helfen on his heels.

Groggin was in Bangor
And West was out to lunch,
And on the end of Bailey's reel
There was a great big bunch.

That night George White was on the job
And tried to find the rub,
We thought we knew what he would do
So Tuliff hid his club.

He snorted and he squinted
As he looked up through the sheet,
Then turned and kicked poor Bailey
With the bottom of his feet.

We said, "You shouldn't do that George,
You've cut him with your heel,
Just give some other guy a chance,
Let Helfen make a reel."

And then the drier felt let loose
And so did White I'm tole
But Wahl was out with Tuliff
Straightening out a roll.

You might laugh about it
But I don't see the joke,
'Cause I'm the guy who crawled in grease
To pull that bunch of broke.

We pulled the felts together
And fastened them with binder.
Then Helfen tried to fix the clutch
And broke our paper winder.

We went behind about ten reels
Before George swore or spoke,
But we didn't listen to him,
He was buried in the broke.

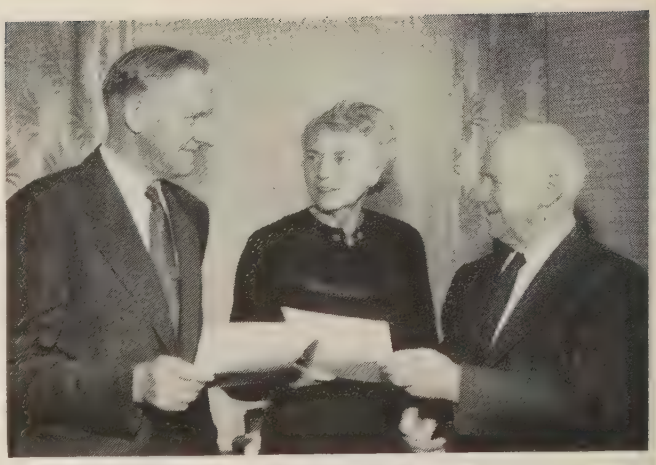
When things were rolling right once more
With a new reel on the drum,
Poor Bailey dropped his grease gun
And knocked off half White's thumb.

We grabbed White in the nick of time
As he made for Bailey's back,
And if Tuliff hadn't grabbed him
He'd have put him through the stack.

It's all right now to laugh boys,
Making paper is all right,
But come around again sometime
When we have a busy night.

Gulf States

President John M. Gallalee of the University of Alabama has announced plans for immediate expansion of the School of Chemistry's pulp and paper technology program at both the graduate and undergraduate level.



Mrs. Mildred W. Warner (center), President of Gulf States Paper Corp., discussing plans for the program at the University of Alabama with its president, John M. Gallalee (right) and Dean Robert D. Brown (left)

An initial gift of $35,000 from the Gulf States Paper Corp. of Tuscaloosa is making the expansion of this curriculum possible.

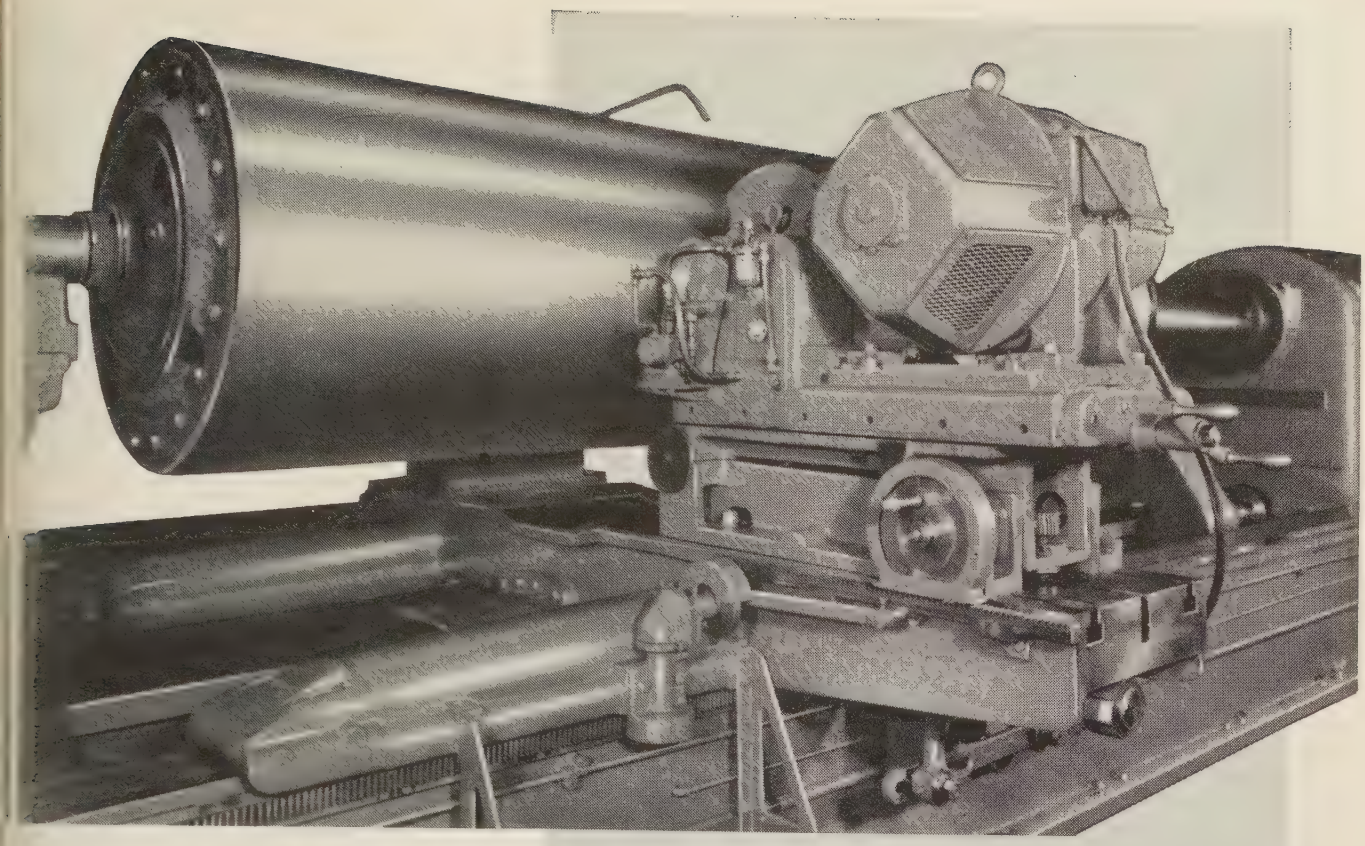
It is planned that this will be continued as an annual donation. The University plans to make a contribution of $10,000 annually and also will provide additional building space for classrooms, laboratories, and offices required by the new program.

Mrs. Mildred W. Warner, President of the Gulf States Paper Corp., in making the funds available to the University, said her company felt that "the increasing importance of Southern forest resources and expansion of the kraft industry in this section require improved production methods, new products and processes and technical personnel."

She said that industry and education should join in meeting these needs. Gulf States established the first paper bag factory in the South at Orange, Tex., in 1912 and one of the early kraft paper mills at Braithwaite, La. Today, Gulf States is one of the nation's biggest producers of paper bags. The kraft process is one in which southern pine is used to produce a strong quality brown paper.

According to Dean Brown, plans are now under way to augment the chemistry school staff to include professors and other technical personnel who are specialists in paper chemistry and in the field of production of pulp and paper from southern pine and other southern woods.

Dean Emeritus Stewart J. Lloyd (center) with Librarian Caroline Stephenson, University of Alabama, and R. R. Fuller, Gulf States Paper Corp.



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The new program will be supplemented by the physical and academic facilities now existing at the School of Chemistry. In addition a number of graduate and undergraduate scholarships and working fellowships will be set up with first consideration going to the sons and daughters of the employees of Gulf States.

Specifically, a four-point program will be undertaken as follows:

1. The offering of basic pulp and paper technology courses at the undergraduate level, these to include—Introduction to Papermaking, Pulping Processes, Paper Technology, Pulping Process Laboratory, Chemistry of Cellulose;
2. Inauguration of graduate instruction in fundamental and applied research on problems of production of wood pulp, paper, and other wood products;
3. Increasing the School of Chemistry's present library of books and periodicals in the pulp and paper field and setting up of an information bureau for the use of the paper industry in this region, and
4. Organizing short training courses designed to give key personnel in the industry an opportunity to keep abreast of the latest production methods.

Gulf States has agreed to make personnel from that corporation available for lectures, consultation on problems of research, and for aid in setting up technical training programs.

It also has extended an invitation to the University to use Gulf States' facilities for familiarizing students with industrial problems and opportunities. Students in the program will be given preference for part-time employment, Mrs. Warner said.

Sorg Paper

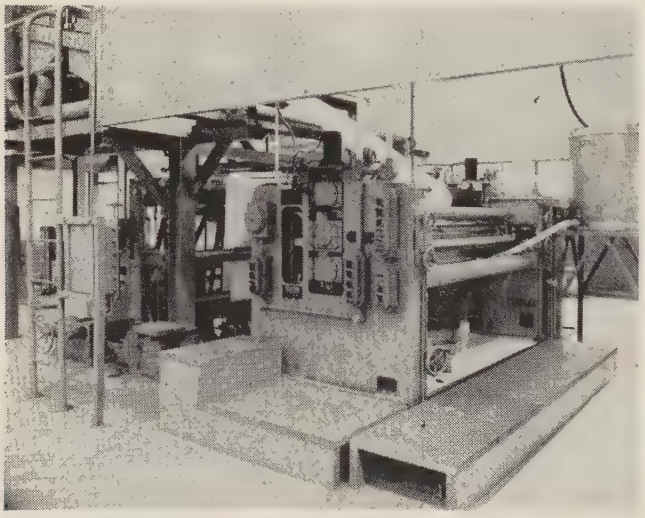
The Dilts Machine Works Div. of The Black-Clawson Co., has recently installed new coating equipment at the Sorg Paper Co. in Middletown, Ohio.

The coating unit, an 80-in. four-roll reverse roll coater, trade-marked "Contracoater," was developed through close cooperation between Sorg and Dilts engineering personnel.

With this new type of coater, principal unit in the 80-in. coating line, the Sorg system will apply a variety of coating materials including latices, resin emulsions, lacquers, organisols and plastisols to paper, fabric, or film.

Precision adjustment of the coating rolls makes possible the application of a wide range of uniform coating thicknesses and weights.

The complete installation comprises a Kohler constant tension shaftless unwind, the 80-in. Contracoater reverse roll coater, an arch oven with radiant superheaters, an exhaust system, a cooling section, and a Kohler two-arm shaftless type winder, plus a sectional d.-c. electric drive.



The Dilts "Contracoater" installation at the Sorg Paper Co.

Union Bag

The Savannah expansion program of the Union bag & Paper Corp. described in last year's annual report, involving a sixth paper machine and the manufacture of semichemical pulp, is proceeding close to schedule despite some difficulties encountered in obtaining the necessary permits, allocations, and actual receipt of critical materials such as steel. As against the original estimate of August, it is now expected that the program will be completed by October, 1953.

During the year the converting plants were also expanded in terms of product range, and construction of a new service plant for the manufacture of multiwall bags in St. Louis was started with an estimated completion date of June, 1953. Plans were also completed (and approved early in 1953) for the construction of a 350,000-sq. ft. warehouse at Savannah to permit steady production schedules being maintained during periods of variation in sales demand.

At Hudson Falls the manufacture of a variety of special-purpose bags continued, and the machine shop and product development facilities were in constant use.

All in all capital expenditures amounted to approximately $12,500,000 during 1952, of which over $11,000,000 was spent for plant improvements and expansion and over $1,000,000 for the purchase of timberlands.

Rayonier

The use of an ultraviolet absorption method for precise determination of complex organic compounds in lignin preparations was disclosed here today by Otto Goldschmid of the research division of Rayonier, Inc., Shelton, Wash.

Dr. Goldschmid described a method in which the spectra of lignin mixtures are determined and then compared with the absorption bands of known compounds. The method provides a relatively quick and accurate tool for difficult determinations in laboratory research on wood derivatives.

Commercially, the most important constituent of wood is cellulose, although more than half of the weight of raw wood is comprised of a mixture of lignins, sugars and other complex compounds which are now wasted or used to a limited extent. Research in noncellulosic wood derivatives, such as lignin, is therefore given prime attention by Rayonier and other cellulose producers because they offer a rich and potentially valuable source of chemicals.

Bird & Son

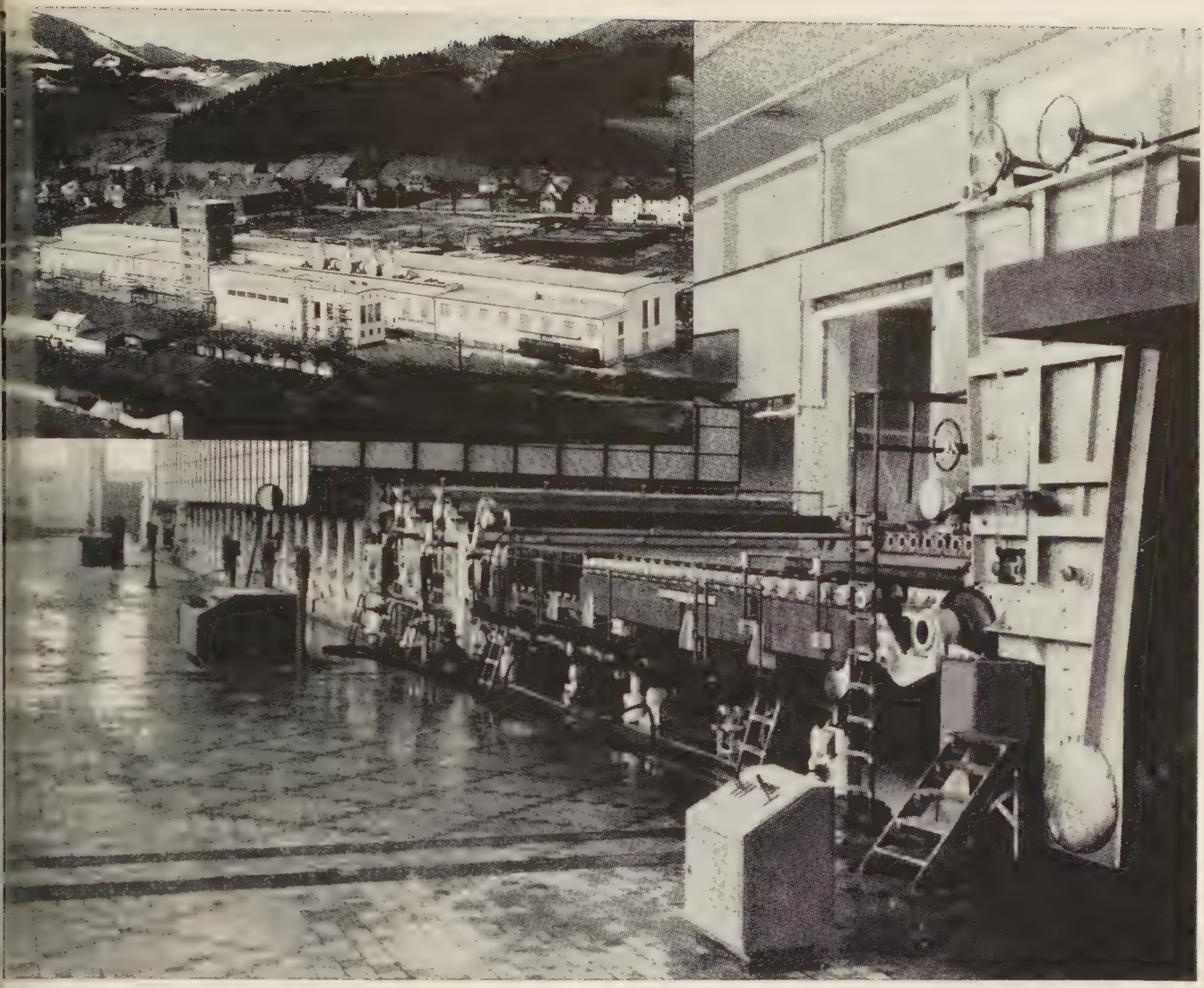
In February Phillipsdale's (Rhode Island) newest machine went into operation. Located in the same machine room with and parallel to, old no. 1 machine, this new no. 3 felt machine produces 50 tons per day of felt for floor covering and roofing products. It is capable of making 148-in. width for 16/4 floor covering production.

A new Goldsmith stream flow vat, especially designed for our type of production, produces a sheet of unusually high quality and uniformity in both width and length. For drying there are 23 five-ft.-diameter driers. To make for faster drying a Ross vapor absorption system has been installed.

Designed and planned for the manufacture of 16/4 felt the machine has a maximum trim of 156 in. It will also be used for producing roofing felt.

Like the Shreveport felt machine, the new machine is driven by a G.E. steam turbine. The driers, drives, and the reel were built by Black-Clawson Co. A modern feature is the motor drive for the cylinder and the suction primary roll. The power for the motors comes from generators driven off the main line shaft. When the machine speed is changed, the power generated changes and the speed of the cylinder and suction primary is automatically synchronized with the rest of the machine.

Another feature is the use of ropes to feed the paper over the driers. On most Bird & Son paper machines this operation must be done by hand, but here there are two sections of



This is the most recent of Bagley & Sewall productions, designed, built and installed for the Murztaler Holzstoff-und-Papier-Fabriks A.G. in the city of Bruck/Mur, Austria, one of Europe's finest and most modern paper mills.

This fourdrinier machine has a wire width of 226 inches and length of 100 feet. Outstanding in design features, from the remote control system to the many engineering innovations throughout the various machine sections, it is one of the most modern papermaking machines in the world, today. Another B & S paper machine designed for efficient and economical manufacture of paper.

International recognition and acceptance of Bagley & Sewall resourceful engineering and precision built papermaking machinery is evidenced by the many installations in leading mills throughout the world.

100th ANNIVERSARY 1853 1953

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driers and in each section the tail of the sheet is fed in between ropes which carry the paper through the drier section.

At the winder is the very latest equipment for handling of the finished product. A kicker pushes the rewound and slit rolls onto a table that can be lowered to floor level where the individual rolls can be picked up by crane and carried to storage. This is a big improvement over the former method of handling which occasionally damaged the rolls as they were taken from the machine.

Equipment supplied by the Bird Machine Co. includes: screens and showers, Vickery doctors, felt conditioners, and consistency regulators.

Great credit for the installation goes to Lester Tarbell, Assistant to Vice-President Ralph Wilkins. Ordinarily in a construction project of this size an outside engineering firm is employed. In this case Mr. Tarbell at Bird & Son was the engineer.

The company now has very adequate facilities for making all its own felt, even when running at capacity in the Floor Covering Plant and the three roofing plants.

Machine tenders for the new machine are Raymond Nolan, Leonard Audet, and John Ellis. Back tenders are John Raposa, Albert Hamel, and Lionel La Grandeur.

St. Helens Modernization

The modernization and expansion program of the St. Helens Pulp & Paper Co., St. Helens, Ore., falls generally into the following broad classification:

1. The pulp mill—including new blow tank, blow heat recovery system, an additional digester and necessary chip storage bin, pulp washing equipment, and pulp storage chests.
2. New 250-ton per day four-stage bleachery.
3. Water treatment plant—including new enlarged river pump station and connecting water lines.
4. New screen room.
5. The beater room.
6. New recovery plant—300 tons per day recovery boiler, new multiple effect evaporators, new causticizing system, and new dry chemical pneumatic handling system.
7. Rebuild of no. 1 paper machine.

Taking these units in the order listed; the new pulp building and the pulp storage tanks were constructed in 1951. The new blow tank, blow heat recovery system, pulp washing equipment, and other units were completed and placed in operation in February, 1952. This part of the program is completed.

The second item, the new bleachery, at the end of 1952 was about 95% complete, and is now in use on a partial basis. The bleachery occupies one half of the new pulp mill building, the bleached pulp washers being located on the same working floor as the washers handling unbleached pulp from the blow tank.

Full use of the new unit is dependent upon completion and activation of the water treatment plant.

The pulp bleachery is one of the most modern in the United States. Capacity will be over 250 tons daily, ample to operate the two paper machines steadily on bleached papers. The demand for bleached papers is increasing faster than for unbleached grades, and we will be in an excellent position to enjoy a goodly share of this growing demand. Bleached grades command a higher price than unbleached, and carry a greater margin of profit, and the effect should be apparent in the company's earnings for 1953, especially in the latter part of the year.

Construction of the new water treatment plant was begun in August. The water treatment plant proper consists of two reinforced concrete tanks of special design for the treatment and clarification of the raw water before it passes into the clear well from which it is pumped for mill uses. Each of these two tanks is 120 ft. in diameter, and $12\frac{1}{2}$ ft. in depth.

The bleaching of pulp to a high degree of whiteness in sufficient volume for our two paper machines requires a tremendous volume of pure, fresh water. One million gallons will be required each hour of the day. The new water treatment plant is designed to handle and purify up to 30 million gallons each 24 hr. This is sufficient volume to service a city of 150,000 people. Completion of the plant is scheduled for May, 1953.

In the screen room six new pulp screens of modern type and design have been installed and are in operation. As older screens are released from service, they are being rebuilt and renovated and moved to their new locations, where they again serve their designed purpose in the production of high quality pulp for the paper machines.

In the beater room, three of the new jordans were placed in operation in 1951. Installation of the fourth jordan was completed, and the jordan placed on the line in the early part of 1952. Pulp storage chests have been tile lined and equipped with modern agitation.

Two tile vertical mixing chests have been constructed and equipped with new agitation; larger pumps have been installed; and the major portion of the iron pipe stock lines has been replaced with stainless steel and asbestos cement pipe.

The new recovery building to house the new recovery boiler and other equipment was well along toward completion at the end of the year. The recovery boiler and other equipment were in the process of erection and installation. Together with the new electrostatic precipitator for recovering chemical dust from the boiler gases, the facilities in this department will be as modern as any in the industry today. Completion is scheduled for June, 1953.

A contract with Beloit Iron Works for equipment to rebuild no. 1 paper machine was placed June 1, 1951. Cost of this equipment is in excess of $1,000,000, against which progress payments of $479,857 have been made. In October, 1952, this contract and orders placed with other suppliers for equipment incidental to the rebuild were suspended, since it appeared additional financing would be necessary in order to complete this part of the program.

Actual costs of construction have run beyond original estimates for a number of reasons, among which may be mentioned delays in scheduled deliveries of materials, higher cost of materials for which fixed price contracts could not be arranged, increases in rates of pay in the building trades, escalator clauses in contracts for equipment, and in some cases the ordering of units larger than at first contemplated, since the relative cost of the larger units is more than offset by economies of operation and increased capacity.

Above are the nine students currently receiving scholarships or grants from the University of Maine Pulp and Paper Foundation. Front row, left to right: Walter E. Pease, Lawrence R. Dimitre, Robert C. Chase, Robert J. Kneeland; rear row: Eugene L. Cunningham, Newell Emery, Rovert M. Ward, Carl D. Perkins, Robert V. Touchette

TRUNDLE ASSOCIATES, INC.

An experienced organization specializing in

CONSULTING SERVICE FOR THE PAPER INDUSTRY

- **Management**
- **Marketing**
- **Manufacturing**
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Our expanded organization, backed by the complete technical facilities of The Trundle Engineering Company, offers you an unusual background of experience on management and operating problems. I truly believe our "experience pool" and record of accomplishment to be unique in the paper and conversion fields. We invite your inquiry at any time.

R. C. Trundle

PRESIDENT

TRUNDLE ASSOCIATES, INC.

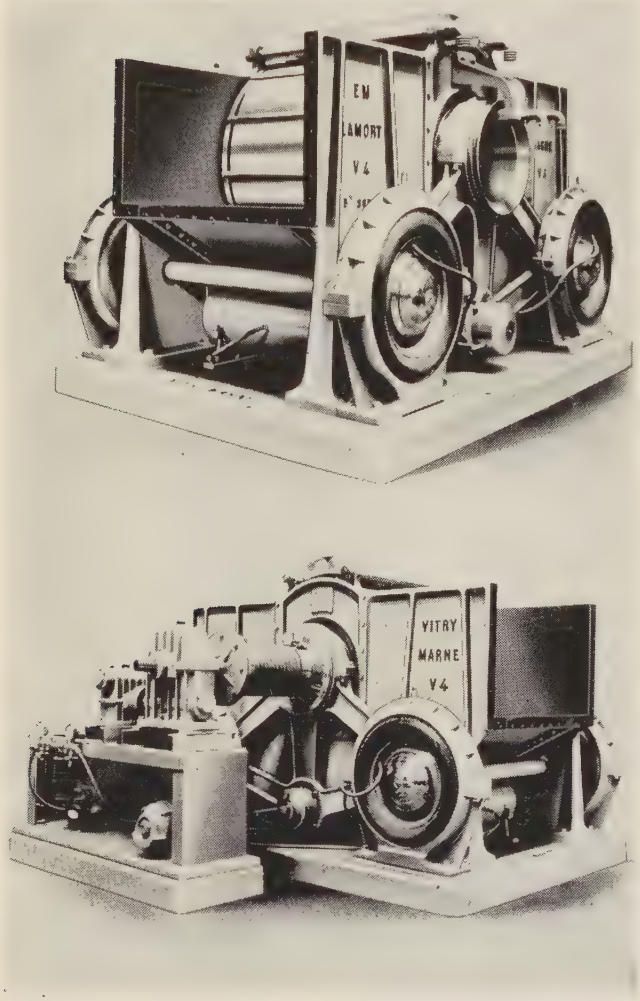
A Subsidiary of The Trundle Engineering Co.

2020 Carnegie Ave., Cleveland, Ohio

E. D. Jones

E. D. Jones & Sons Co., manufacturers of stock preparation machinery, have just completed arrangements to manufacture and distribute in North America two new machines under original patents of E. and M. Lamort Sons, Vitry-Le Francois, France.

The machines, known in Europe as the Lamort high frequency screen and the Lamort cellular filter, have been the subject of lengthy study by the Jones engineering staff, who will apply Jones's wide knowledge and experience of American mill requirements to adapting the machines for the American market.



Two views of the Jones Lamort vibrant screen

The new high-frequency screen, while based on principles already in use in some screens familiar to North American millmen, incorporates a number of mechanical features which represent a considerable improvement over anything now on the market. The Lamort has a simple means of adjusting intensity of stroke without taking the unit completely apart; the shock absorption mechanism, while simpler than in other machines, completely eliminates vibration on vat and foundation.

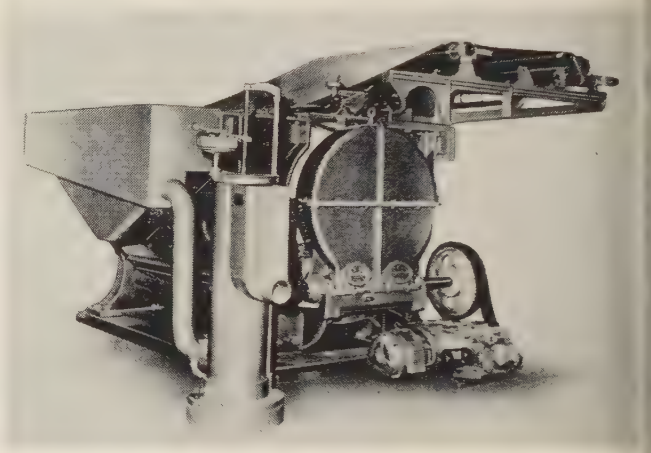
The drum size of the new screen is about 40 by 40 in. The drum speed may be varied from 0.5 to 3.5 r.p.m., and vibrates at about 1430 per minute. Total connected horsepower is about 7.

The cellular filter which can be used for white water, raw water, or pulp thickener has established some notable performance records.

Richard E. Bodette, E. D. Jones & Sons Co.

Norman F. Hoch, E. D. Jones & Sons Co.

At the same time, the appointment of two men of outstanding ability and experience as project engineers was announced by Dwight E. Jones: Richard E. Bodette, in charge of filter development, and Norman F. Hoch, responsible for the screen. Both men have long been associated with stock preparation. Mr. Bodette was for over 4 years Beater Room Superintendent for St. Regis Paper's Deferiet plant; and prior to that was for 13 years Beater Room Engineer at the Wisconsin Rapids plant of Consolidated Water Power & Paper Co. In both these plants the beater room was responsible for water and recovery.



The Jones Lamort cellular filter

Mr. Hoch spent 4½ years at Spruce Falls Power & Paper at Kapuskasing, Ont., where he was Design Engineer, and 7 years as Plant Engineer at Alliance Paper Mills, Merritton, Ont.

Hercules

E. Langford Jones is now Sales Manager of the Virginia Cellulose Dept., Hercules Powder Co., Wilmington, Del.

Monsanto

Monsanto Chemical Co. has entered the field of manufacturing polyethylene plastics, making Monsanto the first company to produce the "big six" in plastics for molding and fabricating. The other plastics are styrene, phenolics, cellulosics, vinyls, aminoplasts, and polyethylene.

G.E.

The General Electric Co., Schenectady 5, N. Y., has issued several new bulletins: "General Purpose Relay" (CR 2790E)

dustrial Power Distribution Idea ok" (GEA-5900); and "Metallic Recti- Power Conversion Units" (GEA- 8B).

NNEAPOLIS-HONEYWELL

nstrumentation, Vol. VI, No. 4, pub- ed by Minneapolis-Honeywell Regu- or Co., Wayne and Windrim Aves., adelphia 44, Pa., contains an article 'Bleaching Pulp," by A. G. Wooler.

ER BROS.

William C. Cantrell was recently named hwestern representative of the Bauer s. Co. of Springfield, Ohio, to replace ather Charles C. Cantrell who is re- g after 17 years with his company. Cantrell will reside in Fort Worth.

S-CHALMERS

Allis-Chalmers Mfg. Co., 828 S. 70th Milwaukee, Wis., has issued new tins: "General Purpose Starter Selec- Guide" (14 B 7733); "A-C Motor Generator Reference Book" (51 R 3); and "A-C Single-Stage, Double- ction Centrifugal Pump Bulletin" SB6146B).

ANAMID

The American Cyanamid Co. is now oducing Parez Resin 614 at its Char- te, N. C., plant. Parez is a liquid tionic urea-formaldehyde resin used to part wet-strength and dry-strength operties to paper.

Technical Bulletin No. 29 describing new sizing agent "Cyron" has been ued by the Paper Chemicals Dept., erican Cyanamid Co., 30 Rockefeller aza, New York 20, N. Y. The new ing material can be fixed on paper der alkaline conditions. It may also applied to the surface of papers.

ANDARD OIL

Standard Oil Co. (Ind.), 910 S. Michi- n Ave., Chicago 80, Ill., has issued a y interesting booklet prepared for its ployees and entitled "Welcome to ndard Oil."

OIT

Beloit Iron Works, Beloit, Wis., is ning an interesting series in the *Wall eet Journal* on the theme "Paper Is re to Stay." The series is intended highlight the past, present, and future portance of paper and of the industry t produces it. An earlier series of ilar ads were run by Beloit on the me, "Imagine America Without per"—*an excellent public service.*

Added versatility for the Beckman Model B Spectrophotometer . . .

To further increase the wide range versatility of the well-known Beckman Model B Spectrophotometer, a Reflectance Accessory is now available for use on opaque, colored samples in solid, liquid or powder form. There are many useful applications for this accessory in the precise evaluation and comparison of color intensities and hues.

For example, diffuse reflectance measurements are useful for accurately controlling the whiteness of talc . . . for controlling artificial coloring of foodstuffs such as butter, catsup, and condensed milk . . . for calculation of dye bath recipes in textile processing . . . for grading the color of paper and the whiteness of flour . . . for matching and controlling shades of powder, rouge and lipstick, paints and inks and many other products where accurate color measurements are essential.

For complete details on Beckman Spectrophotometers and this Reflectance Accessory see your nearest Beckman dealer or write for Data File 30–146

BECKMAN INSTRUMENTS INC.

SOUTH PASADENA 1, CALIF.

Factory Service Branches:
Chicago • New York • Los Angeles

Beckman Instruments include: pH Meters and Electrodes—Spectrophotometers—Radioactivity Meters—Special Instruments

5340

Easily Installed

The attachment consists of an integrating sphere in holder and a sliding sample tray which are easily installed in place of the standard Model B sample compartment and cell carriage.

Precise Measurements

To permit utmost measurement precision, a detent mechanism operated by a convenient push button in the sample tray knob exactly reproduces forward and backward position of the sliding sample tray. The resulting precision is particularly valuable for accurate measurements on samples with rough surfaces or non-homogenous colors.

Readings taken rapidly are reproducible to at least 1%—with careful technique even greater precision is obtained.

Operating Convenience

Special provision has been made so that liquid samples can be conveniently inserted without spilling . . . powdered samples without disturbing the smoothed surface.

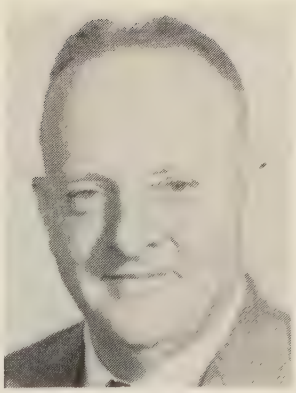
Sample Size

Sample size is approximately 1" x 1 1/4" with a maximum thickness of 5/16"—ample for most applications. Or, by simply rotating the sphere 180° in its holder, larger samples can easily be accommodated.

Quick, Easy Readings

Accurate color measurements are made with great speed and simplicity. First the instrument is adjusted to read 100% reflectance on a white standard (such as MgO), the sample is moved into position and the percent reflectance (compared to the standard) is then read directly from the meter. It's as simple as that—and the three-compartment sample tray permits quick comparison of two samples and a standard on each run.

Norman E. Siems, Philadelphia Quartz Co.



William J. Elkins, Rice Barton Corp.

PHILADELPHIA QUARTZ

Norman E. Siems has been appointed Assistant Sales Manager of the Philadelphia Quartz Co., Public Ledger Bldg., Philadelphia, Pa. Mr. Siems has specialized in water and paper uses of silicates.

RICE BARTON

William J. Elkins has joined the sales department of Rice Barton Corp., Worcester, Mass., as a Sales Engineer.

REICHHOLD

Reichhold Chemicals, Inc., has set up a manufacturing division at Ballardvale, Mass., to produce its extensive line of synthetic resins and basic industrial chemicals used in the paper and plastics industries.

FRANK EGAN

Frank W. Egan & Co., 115 Lincoln Blvd., Bound Brook N. J., has entered the extrusion machinery field with a ne design of a thermoplastic extruder.

ATLAS MINERAL

Atlas Mineral Products Co., Mertztown, Pa., will conduct course in instruction on plastic materials of construction at i plant this Summer. Present plans are to invite all interest corrosion engineers or maintenance men regardless of cor pany affiliation. No tuition will be charged. Subjects w include: basic fundamentals of plant design, properties plastics and ceramic materials used for chemical-resista equipment, protective coatings, rubber and plastic lining chemical-resistant cements, plastic pipe, all plastic structure pipe jointing materials, floor and tank construction, chemic process equipment, waste disposal lines and sewer constru tion, corrosion resistance of specific materials, economic co sideration in corrosion-resistant construction, testing metho and application of corrosion-resistant plastic materials.

Individuals interested in attending these courses shou write to Joseph A. Snook, Vice-President, Atlas Mineral Pro ucts Co., Mertztown, Pa.

BECCO

Buffalo Electro-Chemical Co., Station B, Buffalo 7, N. Y has issued a 32-page booklet on "High Density Bleachi Processes" (Bull. No. 48). Bleaching with hydrogen pe oxide may be effected at 30 to 50% density without impairi pulp quality.

WESTINGHOUSE

Twenty-two thousand employees of the Westinghou Electric Co. have purchased 467,752 shares of the company stock.

CLINTON

Quality Starches

SPECIAL GRADES FOR

- BEATER-SIZING
- TUB-SIZING
- CALENDER-SIZING
- COATING
- ENZYME CONVERSION
- CORRUGATING

CLINTON FOODS INC.

CLINTON, IOWA

"Control Relay Booklet" (B-5817) has been issued by the stinghouse Electric Co., Box 2099, Pittsburgh 30, Pa.
he Westinghouse Sturtevant Div., Dept. T-025, 200 Read- St., Hyde Park, Boston 36, Mass., has issued a catalog 0) on "Industrial Heaters."

BESTOS-MANHATTAN

aybestos-Manhattan, Inc., has moved into its new office warehouse building at 6010 Northwest Highway, Chicago,

BBINS

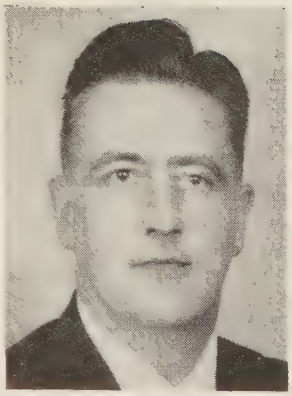
mplete field and shop service for the installation of Saran er and Tygon linings throughout the United States and da has been announced by the Stebbins Engineering & Co., Watertown, N. Y. While specializing in brick, arbon, and similar linings, Stebbins has always provided, e needed, membrane linings protected by brick or tile. addition of Saran rubber and Tygon further increases the pany's ability to meet a wide range of requirements for and alkali-resistant linings in process equipment.

BORO

completely equipped shop for the servicing and repair of oro instruments has just been opened at 1664 W. 4th , Vancouver, B. C., by the Foxboro Co., Foxboro, Mass. ald Rutledge is in charge.
he Foxboro Co. has issued a new bulletin (Bull. 465) on cular Case Controllers."

ENCER CHEMICAL

Spencer Chemical Co., Kansas City, Mo., will build a plant produce polyethylene (45 million pounds per year) near ange, Tex.



Robert E. Collins, Sprout, Waldron & Co., Inc.

R. F. Vokes, Dilts Machine Works Div. The Black-Clawson Co.

SPROUT, WALDRON

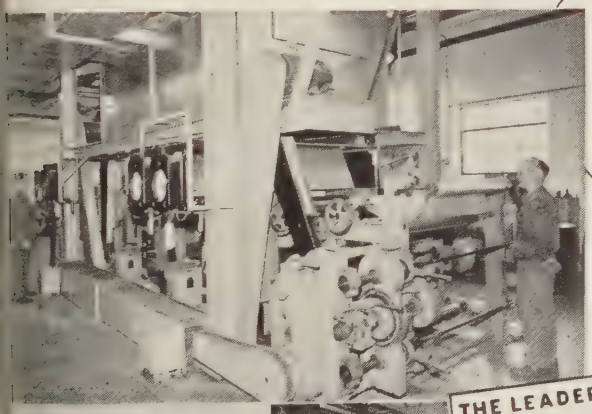
Robert E. Collins has joined Sprout, Waldron & Co., Inc., Muncy, Pa. Mr. Collins has completed five years as a pilot in the Air Transport Command and was formerly Semichemical Pulp Superintendent at the Mechanicville, N. Y., mill of the West Virginia Pulp and Paper Co.

BLACK-CLAWSON (SHARTLE & DILTS)

R. F. Vokes is now General Manager of Dilts Machine Works Div. of Black-Clawson Co., Fulton, N. Y.

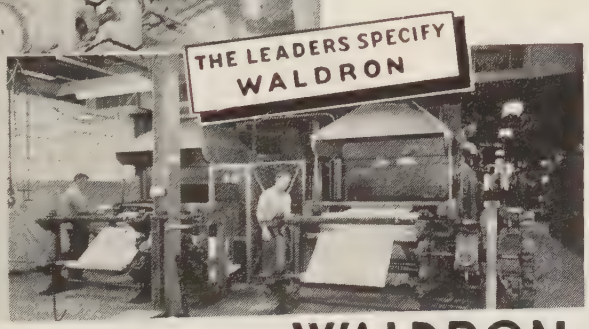
Parsons & Whittemore, Inc., of New York City, and the Black-Clawson Co. are combining their sales of papermaking equipment in the foreign field. Parsons & Whittemore, Inc., has long been engaged in the distribution of wood pulp throughout the world.

again its **WALDRON . .**



Horizontal and Tower Coating and Impregnating for

MICA *Insulator* COMPANY



Above: WALDRON coating equipment and ROSS tower type dryer processing Fiberglas cloth.

Right: WALDRON equipment treating paper base material. ROSS drying units in rear.

For coating and impregnating the various base materials used in making their famous "Lamicoid" products and for coating Fiberglas cloth with silicones in processing their "Empire" products, Mica Insulator Company installed WALDRON equipment to secure a wider range of speed, different types of coating applicators and greater assurance of operating efficiency. Equipment is designed to handle their new types of inorganic coatings now being developed.

Our modern Laboratory is available to evaluate recommended processes. Submitting samples will assist us in our laboratory analysis of your particular problem.

John **WALDRON** Corporation

P. O. BOX 791 · NEW BRUNSWICK · NEW JERSEY

Leaders In Web Process Engineering Since 1827

NEW

OPTICAL BLEACH COATINGS AND CONCENTRATES

Paper technologists generally are familiar with the recent development of colorless dyes which are fluorescent and which re-emit in the specific region just below the edge of the visible blue, i.e., near 4000 A. U. and below. These "dyestuffs" have been added to paper stock as a beater color or as a "tint" in sizes and in litho coatings.

Pyroxylin Products, Inc. has succeeded in formulating a series of paper lacquers, varnishes, laminating adhesive, and wax additives where certain selected optical bleach agents are incorporated in critical and stable concentration.

The resulting products are used in the production of coated, laminated and waxed paper and printed matter having exceptional whiteness, and complete absence of the graying due to wetting,—the usual result of coating a specularly reflecting film over a surface whose whiteness is largely the result of diffuse light scattering.

1. Paper varnishes are offered which can be applied over color printing without degradation of the fine vignettes and pastels. They can be applied by most of the conventional methods.
2. Resin and cellulose base lacquers have been compounded which are capable of actually increasing the subjective brightness of paper.
3. Laminants are offered which have both initial and retained freedom from yellowing.
4. Wax additives are supplied containing optical bleach components,—so that resin modifiers can be incorporated and the original "whiteness" of the paraffins is retained.

Our representatives and engineers will be glad to discuss the use of these products in your operation if you will contact our nearest office.

PYROXYLIN PRODUCTS, Inc.

CHICAGO 32

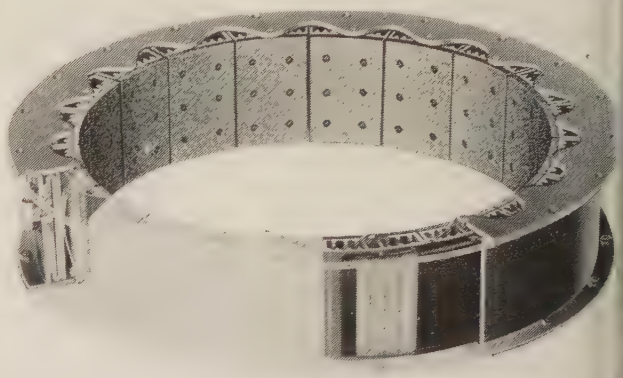
PAOLI, PENNA. WICHITA

Barrie Dixon, formerly Chief Engineer of Walmsley's Ltd has joined the staff of B-C International Ltd. as Deput Managing Director.

Shartle Bros. Machine Co. has issued a new bulletin (Bul letin 14-SB) on "Hydrapulpers." The 13 sizes of Hydra pulpers are described.

FAWICK

Fawick Airflex Div. of Federal Fawick Corp., 9919 Clinto Rd., Cleveland, Ohio, has announced a new air-operated in dustrial clutch, the new Fawick type VC air-ring clutch



The Fawick Type VC air-ring clutch

This completely ventilated clutch of the rigid type provid for transmission of power from the friction shoes throu torque bars to the metal side plates of the assembly.

NORTON

The New York City domestic sales office of the Abrasi Div., Grinding Machine Div., and Refractories Div. Norton Co., Worcester, Mass., has been moved to Greer North Sts., Teterboro, N. J.

PENNSALT

Expansion of production facilities during 1952 and the a quisition of Sharples Chemicals, Inc., have increased the ba of operations of the Pennsylvania Salf Mfg. Co. During 19 about $7,280,000 was spent on expansion. A new 8-milli dollar chlorine and caustic soda plant at Calvert City, K will be completed in 1953.

DE LAVAL

William J. Healy, Sales Manager of the De Laval Turbi Div., has been appointed to the additional post of Sa Manager of the Blower and Compressor Div. of the De La Steam Turbine Co., Trenton, N. J.

KOPPERS PRECIPITATORS

Donald De Vries has been appointed Manager of the Prec itator Dept. of the Koppers Co., Baltimore, Md.

ANTARA

Antara Chemicals Div. of the General Dyestuff Corp., Hudson St., New York 14, N. Y., has issued a 28-page cata covering such products as detergents, wetting agents, emu fiers, and dyeing assistants.

BECKMAN

"Flame Photometry—A New Precision in Elemental Ana sis," a reprint is available from Beckman Instruments, I. South Pasadena, Calif. (Reprint R-56-146). A 28-page ca

g of ultraviolet and visible spectrophotometers (Bull. -146) is also available.

L PAINT

arl Paint Corp., 240 Genessee St., Utica, N. Y., has issued lletin on "Erkopon, a new plastic coating utilizing epon s as for tank linings.

W.

T. Brinkerhoff has been named General Manager of the actories Div. of the Babcock & Wilcox Co., 161 E. 42nd New York 17, N. Y.

. H. Rowand, Chief Engineer of the Boiler Div., has been ed Vice-President of the company.

T

demonstration station has been established at Worcester, s., to assist paper companies to study and evaluate the paper coating system. The station includes a 28-in. h-speed coating machine. Arrangements can be made to sample rolls. The machines can coat paper up to 2000 n. Rice Barton Corp. has been licensed to build all machinery. Information about the demonstration t can be obtained from Trist Colloidal Products Patented, Lexington Ave., New York 17, N. Y.

PENTER STEEL

arpenter Steel Co., Alloy Tube Div., Union, N. J., has ed a 92-page catalog on Carpenter Stainless Tubing.

KER

R. Wolcott Hooker has been appointed Vice-President of e Hooker Electrochemical Co., Niagara Falls, N. Y. Rob- E. Wilkin has been appointed Vice-President and Gen- l Sales manager, succeeding Mr. Hooker.

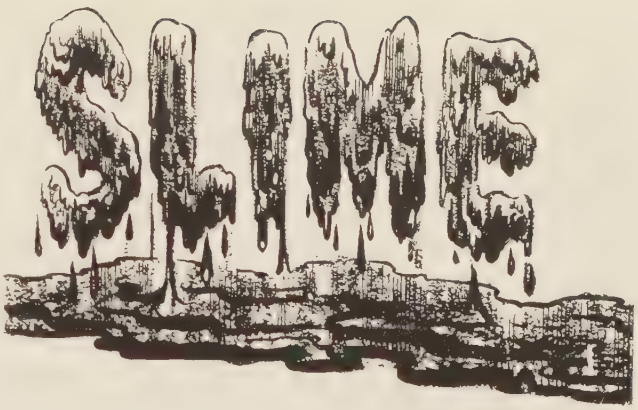
Henry W. Bryson, Jr., has been appointed Sales Service epresentative of the Hooker Electrochemical Co. at Tacoma, ash. His activities will cover caustic soda, chlorine, and monia in the Pacific northwest.

tist's projection of the new Hooker plant at Montague, Mich.

Hooker is now building a 12-million dollar plant at Monta- , Mich. The plant is scheduled for completion by the end 1953. Hooker type S3-A electrolytic cells will be used convert locally mined salt to caustic soda, chlorine, and ogen.

XING EQUIPMENT

Accurate data on blending of fluids in big tanks are secured



There's only one sure way to keep slime damage at a minimum, and that's...

KEEP CLEANING IT OUT!

You can keep slime out of your mill's system by facing the fact that the job is one of good housekeeping! And you can keep cleaning it out on a sure and economical basis with Magnus Slime Remover.

This powerful alkaline cleaner with built-in ultra-fast wetting action digs deep down into slime deposits everywhere in the system...even in spots not reached by ordinary cleaning methods. It loosens the bond of the slime to metal and other surfaces, and completely removes the deposits. It also kills the fungi and bacteria that build slime.

Make It Routine

If you use Magnus Slime Remover on a regularly scheduled cleaning routine, you can keep slime damage virtually at the vanishing point in your mill. And because of its ease of application, the elimination of most hand cleaning operations and its thorough action, you'll find that the cost of keeping slime from accumulating in all parts of the system is lower than by any other method.

LOOK IT UP IN THE PAPER MILL HANDBOOK

On pages 4 to 8 and 19 to 22 of the Magnus Paper Mill Cleaning Handbook you'll find full details on Slime Control with Magnus Slime Remover. Write for a copy of this manual.

magnus

MAGNUS CHEMICAL CO., INC.
104 South Ave., Garwood, N. J.
In Canada: Magnus Chemicals, Ltd., Montreal
Service Representatives in Principal Cities

with the help of a 70,000-gal. test tank recently erected by Mixing Equipment Co., Inc., Rochester, N. Y., manufacturers of Lightnin Mixers.

Quantitative studies on blending operations in the 20-ft. diameter, 30-ft. high tank provide data on single and multiple installations of side entering mixers, location of multiple units, and angle of entrance of mixers. Comparisons between mechanical mixers, air agitation, and liquid jets can be made.

Power measurements on side entering impellers can be taken, with accurate instrumentation, on multiple mixer installations totaling up to 100 hp. and on single mixers up to 50 hp.

The tank permits realistic testing of new-design shaft seals, stuffing boxes, mountings, and weather effects, under field conditions. Seven nozzles, at various positions, permit flexibility in mounting side entering mixers. Mounting facilities for top entering mixers can also be provided.

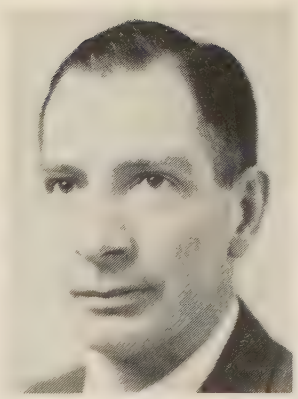
The tank is the newest addition to the company's research-development laboratory, which also employs strain gage and torque-metering instruments, special equipment for ultra-high-speed motion photography of fluid mixing processes, pilot plant equipment for heat transfer, gas dispersion, solids suspension, and other mixing operations. The laboratory can perform other specialized studies in instrumented tanks as large as 10,000 gal.

SUTHERLAND REFINER

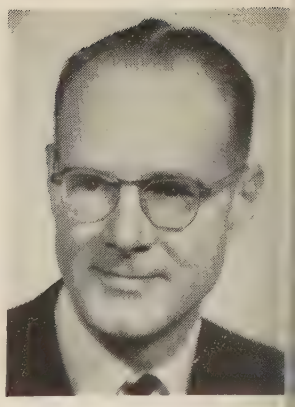
D. D. Carr-Harris has joined the staff of the Sutherland Refiner Corp., Trenton, N. J. Mr. Carr-Harris was formerly with the Anglo-Canadian Pulp and Paper Mills, Ltd., and the Columbia Cellulose Co.

WATERBURY TOOL

Waterbury Tool Div. of Vickers, Inc., Waterbury 20, Conn., has issed an "Engineering Data Book on Large Capacity Variable Delivery Oil Hydraulic Pumps."



D. D. Carr-Harris, Sutherland Refiner Corp.



Herbert W. Beck, Morden Machines Co.

MORDEN MACHINES

Herbert W. Beck has joined Morden Machines Co., Portland, Ore., as Sales Manager. He was formerly with the National Aniline Div., Allied Chemical & Dye Corp.

OBITUARIES

Paul Schlosser

Paul Schlosser, Research Manager of Rayonier, Inc., died on March 12, 1953, at Shelton, Wash.

HERMANN *Improved* CLAFLIN

"Continuous Beater & Refiner"

"HOT STOCK" REFINING

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Dr. Schlosser was born in Wiesbaden, Germany, on Nov. 1894, and graduated from Darmstadt in 1922. From 1923 to 1927 he was assistant to the chemical director of Vereinigte Glanzstoff in Berlin. He came to the United States in 1928 as technical director of the Woonsocket Rayon Co. in Rhode Island. He joined the Rayonier research staff in 1935 as manager of research. He was long identified with the field of cellulose chemistry and rayon.

George A. Thompson, Jr.

George A. Thompson, paper mill representative of B. F. Perkins & Son, Inc., died on March 1 following a long illness.

Mr. Thompson was born in Holyoke, Mass., on June 30, 1902, and joined the B. F. Perkins organization in 1933, following 20 years' experience in the paper industry. He worked 17 years for the American Writing Paper Co. in Holyoke as a machine tender and night superintendent. This was followed by three years as a salesman for the U. S. Envelope Co. in Springfield, Mass. Mr. Thompson was an outstanding authority on the subject of supercalender rolls.

Charles A. Blodgett

Charles A. Blodgett, Technical Consultant for Seaman and Seaman, died of a heart attack in Japan on April 15, 1953.

Mr. Blodgett was born in Portland, Me., on Oct. 23, 1892, and graduated from the Massachusetts Institute of Technology with a B.S. in Chemical Engineering in 1916.

From 1916 to 1931 he worked for the Eastern Manufacturing Co. of South Brewer, Me., as assistant superintendent of the paper mill.

George A. Thompson, Jr.

Charles A. Blodgett

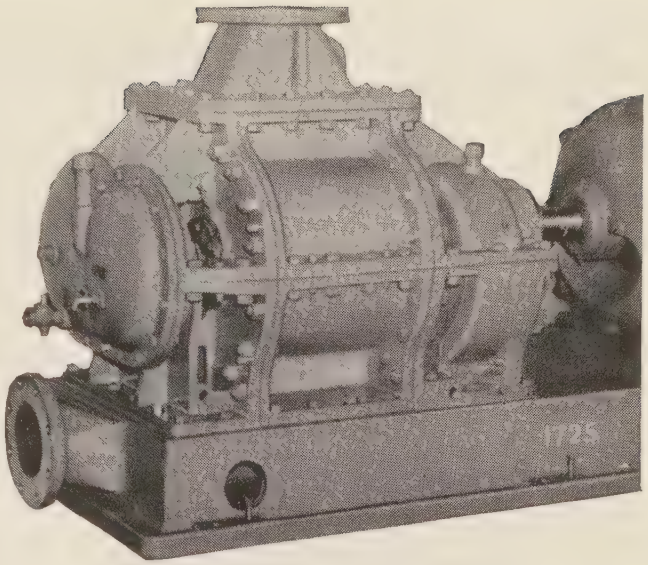
From 1931 to 1940 he was General Superintendent of the I.P.W. Paper Co., Albany, N. Y., and from 1940 to 1948 he was Plant Manager of the American Molasses Co.

In 1950 Mr. Blodgett joined Seaman and Seaman in New York where he acted in a technical consulting capacity for the pulp and paper industry, chiefly in Japan. He recently completed his work of designing and supervising a wood pulp and cotton linter purification plant for Dainippon Celluloid Co. of Japan. Work with other Japanese pulp and paper companies was being initiated at the time of his untimely death.

He was a member of the Technical Association of the Pulp and Paper Industry since 1928. He is survived by his wife, Cynthia, of Brooklyn, N. Y., and his brother, Leo S. Blodgett.

Roland Norton Miller

Roland N. Miller, Technical Adviser to the Research Department of the Oxford Paper Co., Rumford, Me., died at the



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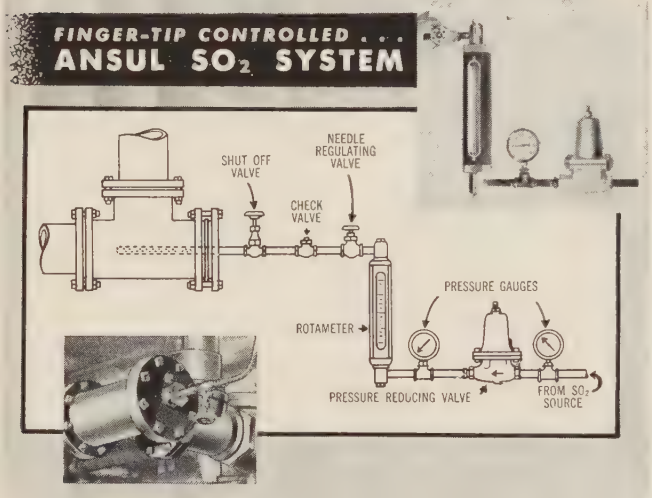

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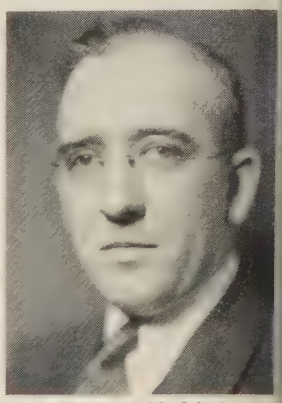
Peter Bent Brigham Hospital in Boston on April 15, 195 following two weeks' illness.

Mr. Miller whose name is well known throughout the i dustry through his co-authorship with W. H. Swanson of tl TAPPI text "Chemistry of the Sulphite Process," published 1928, was born in Appleton, Wis., on Aug. 13, 1889, and gra uated from Lawrence College in 1911, receiving his M. degree from the University of Illinois in 1913.



Roland N. Miller

From 1913 to 1915 he was chemist for the U. S. Gypsum Co. in Chicago, Ill. From 1915 to 1917 he was Junior Chemist for the Bureau of Chemistry, Washington, D. C. In 1917 and 1918 he was Assistant Sulphite Superintendent for the Nekoosa-Edwards Paper Co., Port Edwards, Wis. During World War I he served in The Chemical Warfare Service. In 1919 and 1920 he was Assistant Superintendent of the Interlake Pulp & Paper Co. in Appleton, Wis. In 1920 and 1921 he was Foreman of the acid plant and digester house of the Ha Ha Sulphite Co. in Canada.

He joined the Forest Products Laboratory staff in Madis Wis., in 1921 where he was in charge of investigations relati to sulphite pulp manufacture. After leaving the Fore Products Laboratory he was employed successively as Consultant for the Paulista R.R. in Brazil and served as Sulphite Pulp Mill Manager by the San Juan Pulp M Co., Bellingham, Wash., and as a Chemist for the Champi Fibre Co., Canton, N. C. He joined the Oxford Paper C Rumford, Me., in October, 1929, as Technical Adviser to t Mill Manager and later Supervisor of the pulp mills.

Mr. Miller has been a member of the Technical Associati of the Pulp and Paper Industry since 1922. He is survi by his wife, Dorothy, and a daughter, Mrs. Edward Mugler Boston, Mass.

Paper and Packaging Specification

U. S. GOVERNMENT SPECIFICATIONS

Following is information from W. T. Jones, Paper Section, N tional Bureau of Standards, Washington, D. C., on Fede Specifications of recent issue:

UU.-C-96d (Revision), Cards, Guide, Pressboard (Fil Size); Price, 5 cents

The revision promulgated Feb. 27, 1953, supersedes Fede Specification UU-C-96c, March 17, 1944, and Interim Fede Specification UU-C-0096c, Aug. 15, 1952.

Principal changes are confined to dimensional tolerance ($^1/_{64}$ $^1/_{32}$ in.) and metal eyelet inside diameter ($^7/_{16}$ to $^5/_{16}$ in.). Form and nomenclature now follow current prescribed outlines Federal Specifications.

A printing error appears in paragraph 3.5.6, page 2, Me Tabs. The second sentence should read: "The over-all wi shall be not less than $^3/_8$ inch longer than the width of the wind opening." This error will be corrected by amendment at early date.

UU-P-185b, Paper Computing Machine, Amendment Feb. 16, 1953; Price, 5 cents

This amendment makes possible the use of fiber as well wooden cores (par. 3.7) and provides for a definite sampling p cedure based on the size of the delivery.

TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Alkaline Pulping Committee

A meeting of the Alkaline Pulping Committee was held at the Commodore Hotel, New York, N. Y., on Monday afternoon, Feb. 16, 1953. R. R. Fuller, chairman of the Alkaline Pulping Committee, was unable to attend due to a bout with the flu. H. Y. Charbonnier agreed to act as temporary chairman and called the meeting to order at 2:30 p.m. M. B. Pineo acted as secretary for the group.

The following members of the Alkaline Pulping Committee were present at the meeting: H. Y. Charbonnier, Union Bag & Paper Co., Savannah, Ga.; F. W. Bishop, Southland Paper Mills, Inc., Lufkin, Tex.; R. E. Bowen, North Carolina Pulp and Paper Co., Plymouth, N. C.; K. G. Chesley, Crossett Lumber Co., Crossett, Ark.; K. M. Guest, National Container Corp., Jacksonville, Fla.; E. A. Harper, Hudson Pulp & Paper Corp., Palatka, Fla.; K. D. Running, Halifax Paper Co., Roanoke Rapids, N. C.; David Whetherhorn, Southern Paperboard Co., Port Wentworth, Ga.; A. P. Wright, Camp Manufacturing Co., Franklin, Va.; and M. B. Pineo, Brunswick Pulp and Paper Co., Brunswick, Ga.

In addition to the above members, the following guests were present at the meeting: A. W. Duskin, Crossett Paper Mills, Crossett, Ark.; W. B. Jenkins, Crossett Paper Mills, Crossett, Ark.; C. E. Tyler, Hercules Powder Co., Brunswick, Ga.; Morgan Robinson, Champion Paper and Fibre Co., Hamilton, Ohio; D. C. Gillespie, The Dorr Co., Stamford, Conn.; Richard B. Nelson, West Virginia Pulp and Paper Co., Charleston, S. C.; Charles S. Benz, Scott Paper Co., Chester, Pa.; and Thomas L. Gilles, Brunswick Pulp and Paper Co., Brunswick, Ga.

Bob Fuller, retiring chairman of the Alkaline Pulping Committee, had written to each of the individual members and proposed an agenda for the February meeting. This agenda was accepted and was acted on as follows.

1. Organize for 1953 and select a chairman: Due to the outstanding job which was done with the programing for the 1952 Fall meeting of the Alkaline Pulping Committee in Mobile, Ala., by Fred Bishop, it was suggested that Mr. Bishop be named as chairman of the Alkaline Pulping Committee for 1953. His nomination was seconded and the motion was carried unanimously.

A suggestion was made to back up the chairman of the Alkaline Pulping Committee with a vice-chairman so that the vast amount of work connected with the activities of the committee could be more widespread. A motion was made to nominate Mr. Charbonnier as vice-chairman for 1953. This motion was seconded and carried unanimously.

Both Mr. Bishop and Mr. Charbonnier, accepted the offices of chairman and vice-chairman, respectively.

2. Appoint a committee secretary: M. B. Pineo was duly nominated, seconded, and voted in as secretary of the Alkaline Pulping Committee for 1953. The job was accepted by the secretary.

3. Appoint a program chairman for the Fall meeting: The appointment of a program chairman for the Fall meeting to be held Nov. 18 to 20, 1953, at the Rice Hotel, Houston, Tex., was tabled for the consideration of the incoming chairman. The new chairman appointed a committee of three to work with him to expedite the activities of the Fall meeting. These members accepting this responsibility were, H. Y. Charbonnier, K. D. Running, and M. B. Pineo.

4. Complete plans for the Fall meeting: In regard to the Fall meeting, it had already been announced that it would be held at the Rice Hotel, Houston, Tex., Nov. 18 through 20, 1953. The general subject for the meeting will be "Brown Stock Washing" and J. N. McGovern, chairman of the Semichemical Pulping Committee, has agreed to cover one session with two papers and panel on semichemical pulping. The other three sessions will be used by the alkaline pulping section with papers pertaining to or in connection with kraft pulp washing. It was suggested that each member of the Alkaline Pulping Committee become most active in supporting these sessions with papers or panels.

A review of past Fall meetings of the Alkaline Pulping Section, with regard to their effectiveness, brought out the following points: (1) control and limit the length of the papers; (2) limit the number of papers so that the program does not become overcrowded; (3) emphasize and promote discussions on the content of the papers; (4) papers should be presented somewhat informally and not read verbatim; (5) the chairmen of the various sessions should exercise their prerogative in controlling the length of the papers and their methods of presentation; (6) it was thought that the programs could be made more effective if only a summary of the papers was presented, rather than the full text; (7) if at all possible, mimeographed copies of the various papers should be made available to those present at the meetings.

5. Consider the revision of TAPPI Standard O-400 worked out by the subcommittee: The revision of TAPPI Standard O-400 was accepted in general with the following exceptions: (1) use active alkali as a basis for sulphidity; (2) miscellaneous changes in wording suggested in tentative revision; (3) new usage of the term, "causticity," to denote causticizing efficiency.

It was suggested that the chairman of the subcommittee responsible for the revision of this TAPPI standard poll the entire committee by mail as to these three disputed points and include the results of the previous opinion poll.

6. Mr. Borlew sent word that research project on lignin determination is progressing satisfactorily and probably needs no additional efforts by the full committee. Mr. Borlew reported through acting Chairman Charbonnier.

The controversial matter of finances in relation to the Alkaline Pulping Committee and its activities was introduced. A lengthy discussion on this subject resulted in the decision that the Alkaline Pulping Committee would follow TAPPI rules and have no committee treasury. It was also resolved that a letter of advice be sent to the program chairman for the Fall meeting by the Alkaline Pulping Committee chairman to adjust the charges for this meeting to an amount calculated to merely pay the expenses. It was the consensus of opinion that the Fall meeting should be operated on a pay-as-you-go basis and that no surplus should be created. It is the understanding of your secretary that should the program chairman fail to collect sufficient money to meet his obligation, that National TAPPI will cover the balance due. On the other hand, it is my understanding that any surplus will be turned in to the treasury of National TAPPI.

Under the heading of new business, acting Chairman Charbonnier turned the meeting over to James d'A. Clark who suggested that a subcommittee be formed for the consideration of testing concerning the alkaline pulping industry. Such a committee could then put its results before the Alka-

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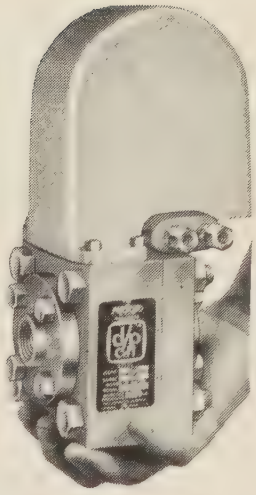

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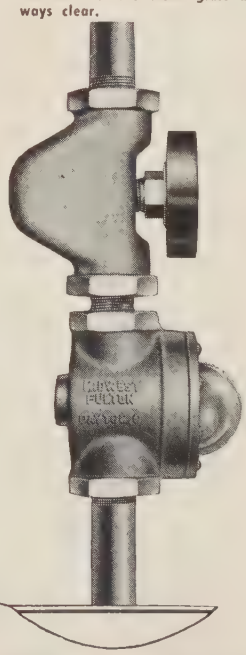

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line Pulping Committee which in turn would report to the Testing Division chairman. This suggestion was approved and seconded and the new chairman is instructed to appoint a representative committee.

Before adjournment, the committee discussed the possibility of scheduling the Winter meeting of the Alkaline Pulping Committee at a time and place other than the National TAPPI Convention. A short discussion emphatically pointed out the desirability of such a move but its impracticability dictated that no change be made. It is the secretary's suggestion, however, that the conditions under which the various TAPPI committees must meet during the Annual TAPPI Convention do not lend themselves to a successful meeting and that Mr. Macdonald should give these conditions his very serious consideration toward their improvement. After all, the work of any committee revolves around the ideas and presentations of its various members and if these ideas and presentations cannot be made in an atmosphere of quiet and order, then the effectiveness of the committee's work is surely jeopardized.

The Winter meeting of the Alkaline Pulping Committee of National TAPPI was adjourned at 3:45 p.m.

M. B. Pineo, *Secretary*

Pulp Testing Committee

The Pulp Testing Committee met at the Commodore Hotel, New York, N. Y., on Feb. 16, 1933. The individuals, in attendance were:

W. G. Chapman, Union Bag and Paper Corp., Savannah, Ga.
C. E. Brandon, Howard Paper Mills, Dayton, Ohio
W. G. Thompson, Andrew Jergens Co., Cincinnati, Ohio
H. A. Smith, Mead Corp., Chillicothe, Ohio
R. M. Drummond, International Paper Co., Glens Falls, N. Y.
N. F. Wilson, Missisquoi Corp., Sheldon Springs, Vt.
Julius H. Mappus, West Virginia Pulp and Paper, Charleston, S. C.
L. V. Forman, Scott Paper Co., Chester, Pa.
F. P. Moden, Anglo-Canadian Pulp and Paper Mills, Ltd., Que., Canada

Mr. Smith opened the meeting with a review of the decisions taken at the Syracuse meeting.

Mr. Brandon commented on the availability of round blotters for automatic couching. He has found that these blotters are not available from the regular suppliers. As a result his mill is purchasing a die for their manufacture. Whether or not this service will be extended to the industry is to be discussed at a later date.

Some discussion was held on the "Zero-Span Tensile Test." There was agreement that this test should indicate some pulp characteristic. The present status is one of a research tool and until considerable data have been collected, its application as a control method is very doubtful.

Mr. Drummond suggested the need for a service which would offer to the industry standard samples which could be used to evaluate the present Valley beater. The subject should be investigated more fully.

In a critical discussion of testing procedures, the point arose that far too many, if not all of the procedures, are nothing more than cook-book recipes. There should be some explanatory notes with each procedure, pointing out what the test hopes to accomplish, what the results mean, and where there are possibilities of errors being made. There is far too little covering the care and preventive maintenance necessary for the various pieces of test equipment. From this discussion, it was evident that considerable work will be necessary if standardization and coordination of pulp testing are ever to be achieved.

F. P. Moden, *Acting Secretary*

Paper Testing Committee

Donald H. Newcomb of the Riegel Paper Corp., New York

. Y., has announced the following personnel of the Paper ing Committee:

H. Newcomb (Chairman), Riegel Paper Corp.
J. d'A. Clark, Longview, Wash.
J. Brabender, Marathon Corp.
W. Codwise, Beaver Wood Fibre Co.
P. Dohne, Dixie Cup Co.
B. Hobbs, National Bureau of Standards
S. Kantrowitz, Government Printing Office
C. Fairbanks, Hamersley Mfg. Co.
F. Wehmer, Electrical Testing Labs.
L. Wehmoff, West Virginia Pulp and Paper Co.
F. McCarty, Nekoosa-Edwards Paper Co.
H. Wiles, International Paper Co.
M. Welker, Western Electric Co.
T. Ward, Riegel Paper Corp.

DONALD H. NEWCOMB, *Chairman*

PPI-ASTM Technical Committee on troleum Wax

e TAPPI-ASTM Technical Committee met at the Com- ore Hotel, New York, N. Y., Feb. 16–17, 1953. llowing are the reports of the committee section and sub- nittees.

ion II—Flow Tests: H. Schindler, Chairman; G. P. ls, Jr., Acting Chairman; L. A. Shipman, Acting etary

Results of a statistical analysis of the data obtained for the 52 Syracuse meeting were presented by the statistical sub- mittee. The analysis showed that the accuracy of the thod for both the standard ASTM needle and the Esso edle was comparable at penetrations at or below 50. For netrations above 50, accuracy was not clearly established, d it was proposed that another round robin be run to pro- de suitable information for a statistical "analysis of vari- ce."

The committee acted to conduct further testing, using the TM needle only, on selected samples of fully refined paraf- and equivalent microcrystalline waxes having high, me- m, and low hardness characteristics in the temperature ge 77 to 115°F. Tests will be conducted at weekly inter- ls using a prescribed method. Twelve companies will par- ipate in this work.

The work on the Abrahams consistometer method was dis- sed, and further participation by members on this test ll continue.

ction III—Oxidation: G. P. Hinds, Jr., Chairman

The results of the last set of cooperative tests were pre- ted. In general the interlaboratory reproducibility owed no improvement over the previous tests and was ll about ±20% of the induction period obtained. The mmittee discussed the direction of its future work. It was dicated that the test with its present limited repeatability ght be satisfactory if no further improvement can be found. e method as it now stands will distinguish between highly ble and highly unstable waxes quite satisfactorily. How- r, it breaks down in marginal cases. It was agreed that e chairman would investigate the reproducibility of other dation tests to see if it was reasonable to expect an im- vement in this method. In the event that further im- vement cannot be made the question of publishing will be cussed at the next meeting.

The method itself was discussed in considerable detail. is can conveniently be broken down into two sections: t, the variables of the oxidation procedure, and second, method of determining peroxide number. Under oxida- n variables the question of the effect of minor changes in the flow rate was raised. Mr. Tkac of Tide Water presented a which indicated that there was no significant difference

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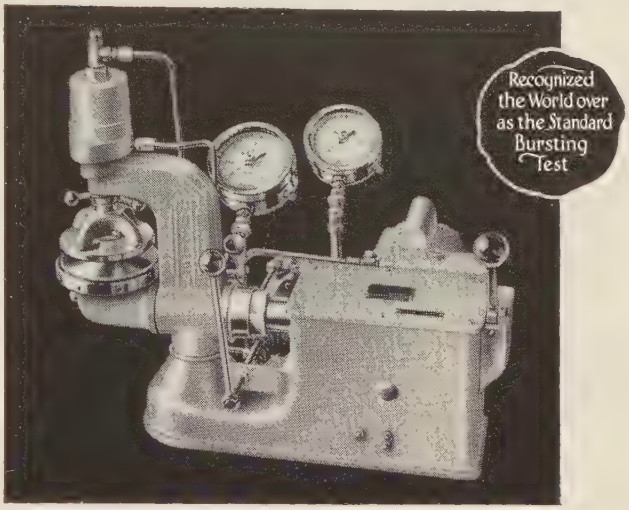

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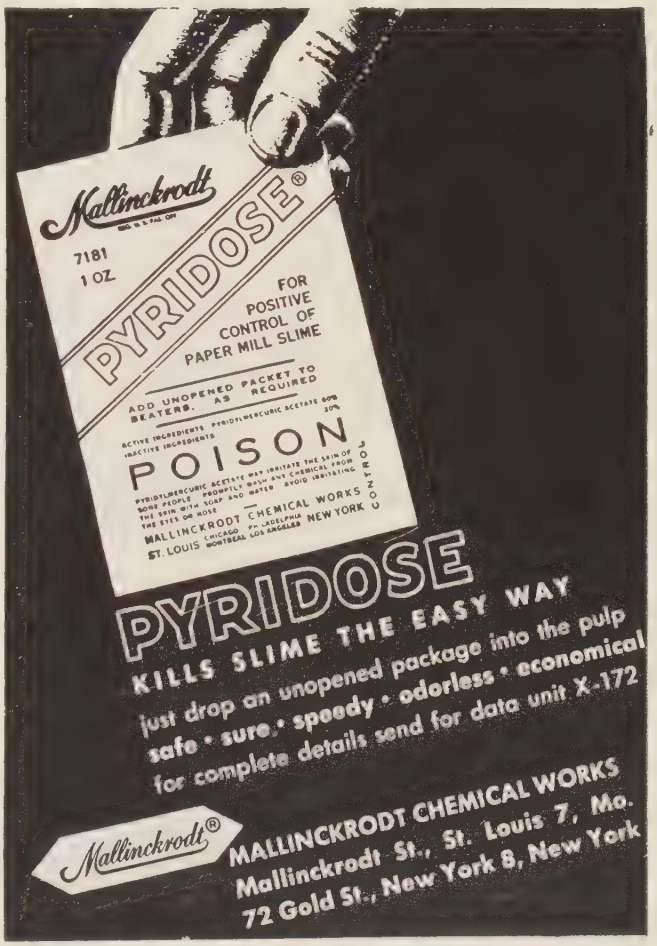
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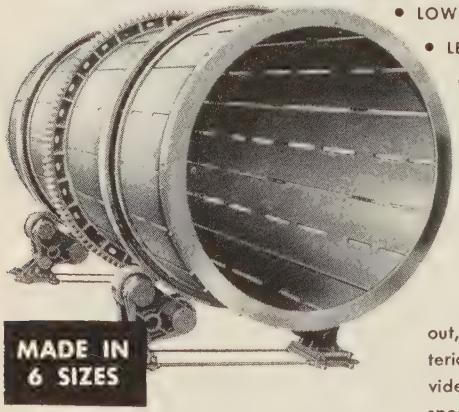

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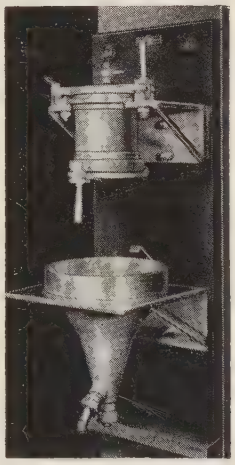

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in the rate of development of peroxides at air flow rates from 250 to 750 cc. per minute. This is in accordance with the committee's past experience which indicated that the rate of 600 cc. per minute chosen for the test was sufficiently high so that wide fluctuation in flow rate had negligible effect.

The desirability of saturating the oxidation air with water was also discussed. The committee had no data on this point and it was agreed that it should be checked. Messrs. Hitchcox and Tkac agreed to compare the effect of dry and saturated air.

The question of impurities in the air stream also arose. No data were available as to what impurities might be present and their effects on the oxidation rate. It was the consensus of the committee that each laboratory should attempt to check its own air supply for possible impurities and to take the necessary steps for removing them. Acidic gases such as SO_2, it was believed, would be the most probable trace constituents.

The importance of shielding samples from direct sunlight during the test was re-emphasized and the absolute necessity for scrupulous cleanliness of all equipment was brought out. Very slight contamination of the glassware used can give highly erratic results.

The peroxide number method itself is apparently open to some criticism. Sets of data obtained in Shell's Houston laboratory indicated that the reproducibility of the peroxide number measurement was as bad as that of the oxidation test in a single laboratory. The standard deviation in the measurement of peroxide number is about 11% and this is the indicated reproducibility of the oxidation test in this laboratory.

Some of the committee members have had trouble with impure reagents in the peroxide number determination. In particular certain batches of carbon tetrachloride have been found to give appreciable blank values. It has also been noticed that on occasion potassium iodide solutions may decompose rather rapidly. The committee recommended that blank values should be run just before and after each set of samples and that when appreciable blanks are obtained the results should be discarded.

There is a possible effect of further oxidation of wax samples after they have been removed from the oxidation test tubes. This possibility is to be investigated by Shell.

The committee agreed that further investigation of the peroxide number determination technique is desirable and it was decided to run some cooperative tests on oxidized waxes to be furnished by the chairman. Two samples will be sent out, one with a peroxide number of about 5 and the other about 20. The peroxide number of these samples will be determined by the present procedure and also by the glacial acetic acid-chloroform procedure submitted by Mr. Wright of the American Can Co. It was agreed that every effort would be made to distribute the samples as rapidly as possible and to forward the results to the chairman as soon as they were available so that further action, if indicated, could be taken before the next meeting.

Section IV—Sensory Tests: G. D. Fronmuller, Chairman

The results of the last round-robin test indicate that a satisfactory method for determining the odors in wax has been agreed upon. However, the description of the type of odor remains in question. In view of this, the committee plans to make two more round-robin tests:

1. Using the acceptable method on a series of samples similar to those previously used but also containing duplicate waxes.

The odors to be defined as follows: (a) no odor—essentially odorless; (b) slight odor—not objectionable; (c) moderate odor; (d) strong objectionable odor.

2. Using the acceptable method but using a series of waxes which have been prepared to meet the four types of odor listed in (1).

Section V—Composition: J. B. Rather, Jr., Chairman

Section V—Composition met on Feb. 4, 1953, in Cleveland, Ohio. Following a review and approval of the minutes of the Sept. 12, 1952, meeting of this section in Syracuse, N. Y., the following business was transacted.

I. Determination of Oil Content

Results were announced of a letter ballot of the entire TAPPI-ASTM Technical Committee on Wax with regard to the proposition that the Proposed Method of Test for Oil Content of Petroleum Waxes, which appears as Appendix IX of the 1952 ASTM D-2 Standards, (1) replace ASTM method D 721–51 T as a tentative standard and (2) be accepted as a tentative TAPPI standard. Publication of the proposed method for oil content is being recommended to both ASTM and TAPPI as a tentative standard.

At the June 24, 1952, meeting of Section V, a cooperative test program was started with the objective of obtaining better precision data on the determination of oil content of paraffin waxes using the Proposed Method of Test for Oil Content of Petroleum Waxes. The results of this work indicate a definite improvement in the precision of the test. On the basis of the latest cooperative data, and giving due consideration to accepted statistical concepts, a revised section on "Precision" was presented, which the section agreed should be incorporated in the Proposed Method of Test for Oil Content of Petroleum Waxes when this is published as a tentative standard.

II. Extension of Scope of ASTM Method D 938–49, "Congealing Point of Pharmaceutical Petrolatums"

Subsequent to action initiated at Section V's September, 1952, meeting in Syracuse, opinions were solicited from the entire technical committee relative to whether the scope of method D 938–49 should be extended to include petrolatum and microcrystalline waxes in addition to pharmaceutical petrolatums.

The chairman summarized replies which have been received to date with regard to this matter, most of which have been against the proposal. No further action was taken.

III. General Discussion of Melting Point Methods

The following points were brought out:

(a) In the paraffin wax melting point method, ASTM D-87, it had been called to the Section's attention previously by the Institute of Petroleum that stirring may be eliminated. Results obtained by two of the Section's members corroborate the I.P.'s findings. It is also understood that Sun are now using cooling curves for paraffin wax and that good correlation with ASTM D-87 is obtained. Marathon Corp. have had successful results using a similar method.

(b) With regard to microcrystalline wax melting point, the shortcomings of ASTM D-127 have been the subject of consideration in the past. The Section is interested in investigating other possible procedures, but has no definite program at this time largely because of the lack of alternative methods to study.

The Section decided that a questionnaire should be sent to the members of the TAPPI-ASTM Technical Committee on Petroleum Wax:

(a) To find out what methods are currently being used in determining melting points of paraffin and microcrystalline waxes.

(b) To request that the members submit copies of any new methods or modifications of existing procedures for melting point of either paraffin or microcrystalline waxes for consideration and possible cooperative study by Section V.

Section VI—Blocking Points: H. F. Hitchcox, Chairman

Data from the cooperative wax blocking tests on 18 waxes and two waxed papers were received too late to make a proper

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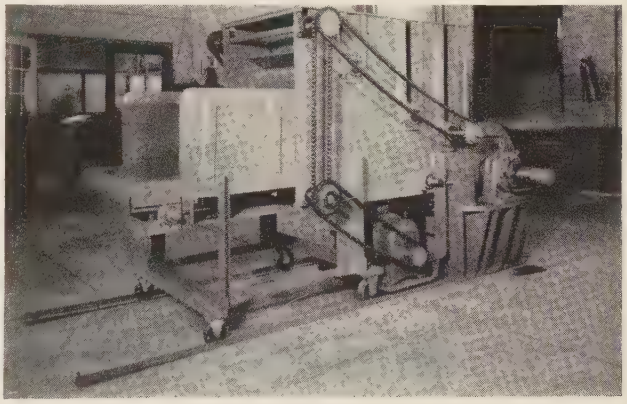

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statistical analysis. However, it was apparent from a quick comparison that the maximum deviation between laboratories for a given wax was no greater, and perhaps less, with the temperature gradient method than with the mercury method. Moreover, the standard deviation with the gradient method was about 1.5 and 2.0°F. for air and water-chilled samples, respectively. In view of these facts plus the operational and safety advantages for the gradient method, the committee members present voted unanimously to drop the mercury method from consideration as a blocking test for unblended paraffin waxes.

Blocking results on the air-cooled samples generally showed excellent agreement between laboratories. This proved that the problems of calibrating the blocking plates, measuring the temperatures accurately, and agreeing on the selection of blocking points had been reasonably well solved. About half the laboratories noted significant differences in the blocking points of the water-chilled strips as compared to the air-chilled strip for 2 to 5 of the waxes. The other laboratories did not find these differences. This indicates that coating conditions are more critical for unblended paraffin waxes than had been previously recognized by the committee.

Accordingly, another round-robin test was agreed on. Both air and water-chilled waxed papers will be examined. Also, coating conditions such as water temperature, rate of cooling, and wax coating weight were standardized within much closer limits for the Marathon Corp. and Standard Oil Development Co. versions of the test.

It is hoped that these measures will have improved the accuracy sufficiently to introduce the method as a "suggested" TAPPI standard procedure within the next year. If so, the committee will enlarge the scope of the test to include the determination of the sticking point of waxes and the blocking characteristics of paraffin wax blends.

Section VII—Sealing Strength: G. C. Borden Jr., Chairman; J. H. Kirk, Secretary

It was decided to abandon the test program set up at the Syracuse meeting because of a mixup due to failure in getting the samples distributed in time. Also, from the few reports received, it was indicated some cooperators failed to follow the rules set down for the program. The results of the tests completed will be reviewed by a committee and the data distributed to committee members. A new set of samples will be distributed for testing in accordance with a definite test procedure. Deadline dates were set for various phases of the program in order to get the final results tabulated and distributed before the next meeting. The proposed method will be published in TAPPI as planned.

Section VIII—Scuff and Gloss: G. P. Mueller, Chairman

Section VIII met at the Commodore Hotel on Feb. 17, 1953, during the annual TAPPI meeting. The chairman polled the members to determine how many wanted to participate in a round-robin test of scuff. It was agreed that four waxes of varying degree of scuff resistance would be applied to paper by the chairman and circulated to participating members.

Richard S. Hunter distributed copies of his recent paper on gloss, and discussed the paper as well as the problems involved in the measurement of gloss. It was reported to the Section that The Institute of Paper Chemistry had been requested to set up a research project to study gloss, but that no suggested program had yet been set up for approval.

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W. J. Yates, Shell Oil Co., 50 W. 50th St., New York, N. Y.
G. P. Hinds, Shell Oil Co., Houston Refinery, Box 2527, Houston, Tex.
N. J. Gothard, Sinclair Oil Co., Control Lab., 400 E. Sibley Blvd., Harvey, Ill.
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W. E. Scovill, Standard Oil Co. (Ohio), Midland Building, Cleveland 15, Ohio
C. J. Johnson, Pollock Paper Corp., 2236 S. Lamar, Dallas 2, Tex.
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J. B. Rather, Jr. (Chairman), Socony-Vacuum Labs., 412 Greenpoint Ave., Brooklyn 22, N. Y.
R. J. Askevold, The Pure Oil Co., Research & Development Labs., Crystal Lake, Ill.
W. Nelson Axe, Phillips Petroleum Co., Bartlesville, Okla.
J. A. Bolt, Standard Oil Co. (Ind.), Research Dept., P.O. Box 431, Whiting, Ind.
N. J. Gothard, Sinclair Refining Co., 400 E. Sibley Blvd., Harvey, Ill.
H. M. Hancock, The Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.
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V. J. Tkac, Tide Water Associated Oil Co., E. 22nd St., Bayonne, N. J.

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H. F. Hitchcox (Chairman), Standard Oil Development Co., Research Div., P.O. Box 51, Linden, N. J.
R. J. Askevold, The Pure Oil Co., Research and Development Labs., Crystal Lake, Ill.
Donald W. Cushman, Socony-Vacuum Labs., 412 Greenpoint Ave., Brooklyn 22, N. Y.
R. R. Davis, Sinclair Refining Co., 400 E. Sibley Blvd., Harvey, Ill.
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A. C. Smith, Jr., The Atlantic Refining Co., Research & Development, 2700 Passyunk Ave., Philadelphia, Pa.
W. L. Thompson, Mid-Continent Petroleum Corp., Tulsa, Okla.
Vince J. Tkac, Tide Water Associated Oil Co., Technical Service Lab., Bayonne, N. J.
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E. A. Yermakoff, General Foods Corp., Research & Development Dept., 11th & Hudson Sts., Hoboken, N. J.

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Kirk, J. H. (Secretary), Sinclair Research Labs., Inc., Harvey, Ill.
Askevold, R. J., The Pure Oil Co., Research & Development Labs., Crystal Lake, Ill.
Coffman, H. H., Bareco Oil Co., Barnsdall, Okla.
Cushman, Donald R., Socony-Vacuum Oil Co., Socony-Vacuum Labs., 412 Greenpoint Ave., Brooklyn 22, N. Y.
Fronmuller, G. D., Commonwealth Color & Chemical Co., 3240 Grace Ave., New York 67, N. Y.
Funk, C. S., Western Waxed Paper Co., P.O. Box 125, San Leandro, Calif.
Gunning, J. R., Provincial Paper, Ltd., 388–396 University Ave., Toronto 2, Canada
Hanson, J. E., California Research Corp. (Standard Oil of Calif.), 576 Standard Ave., Richmond, Calif.
Hinds, G. P., Jr., Shell Oil Co., P.O. Box 2527, Houston 1, Tex.
Kapala, Theodore, Army QMC Testing Labs., 2800 S. 20th St., Philadelphia, Pa.
Kinsel, A., L. Sonneborn Sons, Daugherty Refinery, Petrolia, Pa.
Gianacakes, P. J., Standard Oil Co. (Ind.), Whiting, Ind.
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Schindler, H., L. Sonneborn Sons, Daugherty Refinery, Petrolia, Pa.
Skeist, Irving, Newark Paraffine & Parchment Paper Co., 50 Jelliff Ave., Newark 8, N. J.
Tench, J. D., Sun Oil Co., Marcus Hook, Pa.
Turner, William R., The Atlantic Refining Co., P.O. Box 8138, Philadelphia 1, Pa.
Van Esselstyn, S. T., Padgett, John W. (Alternate), Moore & Munger, 33 Rector St., New York 6, N. Y.
Vaurio, Frans, Institute of Paper Chemistry, Appleton, Wis.
Webber, Alfred C., E. I. du Pont de Nemours Co., Arlington, N. J.
Wheeler, Robert A., The Texas Co., Box 712, Port Arthur, Tex.
Yermakoff, E. A., General Foods Corp., Central Labs., 11th & Hudson Sts., Hoboken, N. J.

Section VIII—Scuff and Gloss

G. P. Mueller (Chairman), Marathon Corp., Menasha, Wis.
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G. P. Hinds, Jr., Shell Oil Co., P.O. Box 2527, Houston 1, Tex.
T. A. Howells, Institute of Paper Chemistry, Appleton, Wis.

J. W. Padgett, Moore & Munger, 33 Rector St., New York 6, N. Y.
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Joseph Walker, The Pure Oil Co., Research & Development Labs., Crystal Lake, Ill.
D. R. Cushman, Socony-Vacuum Oil Co. Labs., 412 Greenpoint Ave., Brooklyn 22, N. Y.
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Fundamental Research Committee

A meeting of the Fundamental Research Committee was held on Monday, February 16, with a full attendance which included G. A. Day, G. K. Dickerman, R. M. Dorland, Gerald Greenwood, W. M. Hearon, D. T. Jackson, J. R. Salvesen, R. H. Savage, J. C. Wollwage, and H. F. Lewis, chairman.

The meeting was devoted to a consideration of three subjects. The first dealt with the program being put on by the Fundamental Research Committee during the current TAPPI meeting. The chairman reported a full program of general papers for the Tuesday session and a good group of speakers for the symposium on Wednesday morning on Management of Research with subjects as outlined by the committee in its earlier meetings. In the afternoon there would be a panel in which questions and answers would be called for. The afternoon panel was made up of the members of the Fundamental Research Committee with the exception of R. H. Savage and with the inclusion of Robert Seidl of the Forest Products Laboratory.

The second subject under discussion dealt with the research program of the committee. It was decided to recommend the continuance of the study on "The Nature of the Primary Walls of Fibers" under Dr. Wise at the Institute. This is TAPPI Project 30. An appropriation of $2500 was recommended. Also to continue support of the work at the University of Maine on "Dye Adsorption" under the general supervision of Dr. Thode, TAPPI Project 31, in the amount of $2800. It was reported that the program at the Forest Products Laboratory by Dr. Chang on "The Botanical Study of North American Barks of Interest to the Pulp and Paper Industry," TAPPI Project 44, was now under way. A number of other projects were considered, and after considerable discussion the committee decided to support three, including a continuance of the work at Bucknell University after a lapse of one year on "Fundamental Studies on Lignin" to the amount of $2500, a study by Dr. Brauns at The Institute of Paper Chemistry dealing with "The Chemical Nature of the Sulphonation of Lignin During the Neutral Sulphite Process" to the extent of $3000, and a project request by Mr. MacLaurin in the Pulping Group at The Institute of Paper Chemistry on "The Fundamental Nature of the Neutral Sulphite Pulp Reaction" to the extent of $5000. This report was written up and submitted to Dr. Parsons of the Research Appropriations Committee prior to the meeting of their committee during TAPPI week.

Considerable discussion then followed as to how we should proceed during future years in the matter of requests for TAPPI grants, for it seemed probable that there would be an increase in requests as the committee activity increased. It was decided that we should develop a routine schedule by which requests for grants would be accepted before possibly December 1 in order to give them consideration prior to the TAPPI meeting. Some attention will be paid to this during the present Spring.

The third subject up for discussion was the joint meeting with the Fundamental Research Committee of the Canadian Pulp and Paper Association on "The Fundamentals of the Paper Machine." This had earlier been announced for 1953, but due to the meetings in Stockholm this year it was decided some time ago to change the date from 1953 to 1954. By doing so we will get the support of European scientists who work in the field and would attend the meeting. A number of members of the Canadian Fundamental Research Committee were invited to join with us for this discussion, including the chairman, K. C. Logan, and J. M. McLimerick, G. N. Pepper, G. H. Tomlinson, and Douglas Jones, executive secretary of the Canadian Association. After considerable discussion, it was decided to set as dates for the meeting October 6, 7, and 8, 1954. The location of the meeting will be Appleton with the possibility of holding a part of the meeting in Madison at the Forest Products Laboratory provided they are agreeable.

HARRY F. LEWIS, *Chairman*

Microbiological Committee

The Microbiological Committee met at the Commodore Hotel, New York City, at 2 p.m. on Feb. 16, 1953. Present at the meeting were:

B. F. Shema, Institute of Paper Chemistry (Chairman)
J. W. Appling, Buckman Laboratories, Inc.
H. Berbaum, Nuodex Products Co., Inc.
G. A. Cruickshank, National Aluminate Corp.
W. F. Holzer, Crown Zellerbach Corp.
C. G. Humiston, Dow Chemical Co.
R. B. Martin, Wallace & Tiernan Co., Inc.
H. C. Stecker, Gallowuhr Chemical Co.
R. S. Williams, R. T. Vanderbilt Co., Inc.

C. G. Humiston was appointed secretary of the committee for the year 1953.

Mr. Shema announced the resignation of R. F. DeLong as chairman of the committee. The secretary was directed to write a letter of appreciation to Mr. DeLong for his past services to the committee.

The possibility of increasing the interest and participation of more members of the pulp and paper industry in the committee and its activities was discussed. It was proposed to contact various individuals and concerns who might be interested in taking a more active part in the work of the committee. Various means for stimulating greater interest in microbiological problems were considered.

James d'A. Clark proposed that the committee consider devising a standard test method for B.O.D. determination of mill effluent waters. Since this is primarily a microbiological determination it should fall within the scope of this committee. This matter will be considered further but no definite action was taken at the meeting.

W. F. Holzer discussed various aspects of the proposed TAPPI monograph on the Microbiology of Pulp and Paper. The Executive Committee has approved the project and appropriated the necessary funds for its completion. J. W. Appling, chairman of the monograph subcommittee, will send out instructions as to format, deadline for completion of the manuscripts, and other pertinent information to the various contributors as soon as possible.

Plans for the 1954 meeting were discussed. A concerted effort will be made to obtain a sufficient number of technical papers to provide a microbiological session at the Annual Meeting. A panel discussion dealing with microbiological problems in the pulp and paper industry was also considered as an alternative program. The possibility of having a joint session with the Water Committee was discussed since there are a number of problems of mutual interest to both groups that might be taken up.

The report of the subcommittee on mildew resistance in paper and paperboard was deferred until the Wednesday afternoon meeting of the committee. At that time the results of the round-robin evaluation of the proposed tentative standard method were presented. After considerable discussion, revisions and modifications in the method were de-

cided upon. The method will be rewritten and submitted to the national committee for adoption as a tentative standard method.

The meeting was adjourned at 4:15 p.m.

C. G. Humiston, *Secretary*

Statistics Committee

The Statistics Committee met at the Hotel Commodore, New York, N. Y., on Feb. 16, 1953.

Present were the following:

John F. Langmaid, S. D. Warren Co., Cumberland Falls, Me.
Maynard S. Renner, Dewey and Almy Chemical Co., Cambridge, Mass.
Charles A. Bicking, Research & Development Div., Office of the Chief of Ordnance, Washington, D. C.
A. H. Croup, Hammermill Paper Co.
George R. Shaw, Taylor Fibre Co., Norristown, Pa.
Fred R. Sheldon, Buffalo Electro-Chemical Co., Buffalo, N. Y.
Stewart Otto, Continental Can Co., Van Wert, Ohio
E. Sutherland, Personal Products Corp., Milltown, N. J.
J. Broughton, University of Rochester
W. R. Purcell, Brown Co., Berlin, N. H.
R. T. Trelfa, Watervliet Paper Co., Watervliet, Mich.
J. F. Theriault, Robert Gair Co., New London, Conn.
Alfred H. Nadelman, Western Michigan College, Kalamazoo, Mich.
Charles M. Koon, Oxford Paper Co.

Election of Officers. The present chairman and secretary were reelected.

Summer Courses. John Langmaid reported that the Summer course at the University of Maine had been successful: 35 men from 28 paper mills from 15 states had attended. Expenses were covered and a small profit was turned in to TAPPI. A similar course will be given this Summer at Western Michigan College. Thirty-five are needed to insure the course being given but Dr. Nadelman anticipates that the registration will be closed well before the beginning of the course. He stated that the Statistics Committee will be most welcome at Western Michigan College and that the college will do everything within its power to make this Summer visit as satisfactory as possible for those attending.

Four outside speakers, Herb Somers, C. A. Bicking, Dick Trelfa, and Fred Sheldon have already been lined up and four more are needed.

Report of Subcommittee on Data Sheets and Discussion. Four data sheets are now ready for publication—Introduction, Selective Bibliography, Control Charts, and Control Charts for Basis Weight. Replies to the committee's questionnaire favored data sheets. Further arguments favoring data sheets were:

Data sheets are kept collected whereas TAPPI monographs may get lost or mislaid; data sheets can be put out piecemeal without the delays that preparation of a monograph would entail; they can be more easily revised—an important consideration when this development is still in its growth stage.

It was agreed that the responsible subcommittee chairman will have full authority for publication of data sheets with the understanding that it is his responsibility to see that data sheets include divergent views and fairly represent the thinking of the entire committee. All TAPPI publications require approval of the TAPPI Editorial Board. Trelfa pointed out the need for Statistics Committee representation on the TAPPI Editorial Board as the number of statistical papers increases and it was agreed that Langmaid would make the necessary arrangements with TAPPI.

The Subcommittee on Data Sheets asked for guidance from the whole committee with respect to form and it was agreed that the present introductory material should be presented as understandably as possible. It was moved and voted that TAPPI be asked for a grant to aid in the preparation of data sheets. The subcommittee asked for ideas on subjects for data sheets. Trelfa suggested design of experiments.

Report of Committee on Sampling Room Plans. This report was read by C. A. Bicking and a copy is appended.

In the following discussion, Trelfa stated that the greatest amount of disagreement comes with respect to sampling plans for attributes generally, e.g., calender cuts, color lumps, etc., because of their nonrandom distribution.

Bicking, as chairman, will continue the program but would, however, like to receive suggestions from anyone interested in this important problem. It was agreed that scope of the work includes sheet and roll sampling. The great magnitude of the problem was recognized as well as its research nature.

Trelfa pointed out that the fundamental problems here were similar in magnitude to the fundamental problems the Coating Committee was handling. This latter committee is now planning to present a proposal to TAPPI for setting up a TAPPI Research Foundation to study industry-wide problems. This work would differ from Paper Institute work in that it would deal with common problems of a practical type as distinguished from fundamental studies carried out by the Institute.

The committee agreed that a proposal of this type fell in line with the original feeling of the committee that the problem of sampling room plans would ultimately and necessarily be referred to an outside agency. Consequently, it was moved and voted that the Statistics Committee go on record as favoring establishing a Research Foundation as proposed by the Coating Committee. Bicking will make a preliminary outline of the scope of the work of the subcommittee on sampling plans and submit it to the Statistics Committee full membership and possibly also to members of the Statistics Committee Course for approval and recommendations.

Representation on ASTM Committee. Trelfa, who has been representing the TAPPI Statistics Committee on ASTM Committee D-6 on Paper and Paper Products, stated that this committee was very active and that, because of other commitments, he was unable to give it the amount of time that active participation required. He pointed out the importance of having a TAPPI Statistics Committee representative on this committee, particularly because of the legal and Federal contract implications. The committee agreed that Trelfa would be asked to stay on the ASTM committee as a TAPPI representative but strictly in an editorial capacity and that John Langmaid would make necessary arrangements with ASTM.

Proposed ASQC Committee on Paper and Graphic Arts. Langmaid read Dr. Lace's letter proposing this committee. It was agreed that the TAPPI Statistics Committee would be glad to cooperate with any such ASQC activity and that specifically the TAPPI committee is interested in an interchange of editorial review. Here, Purcell pointed out the desirability of the TAPPI Committee on Statistics having editorial review of ASQC papers on statistics in the paper industry from a technical papermaking point of view and similarly of ASQC having editorial review of TAPPI statistics papers from the Quality Control point of view. It was pointed out that copies of any correspondence with respect to this matter should go to Dr. Toulouse, coordinator of the technical committee and divisions and also to Edward B. Haden, Executive Secretary, Room 5036, American Society for Quality Control, 70 E. 45th St., New York 17, N. Y.

Proposed Procedure for T 213 m-39—Dirt in Pulp. In reply to the Statistical Committee offer (voted at the 1952 Annual Meeting) to aid other TAPPI committees with problems, one request for help has been received in connection with the above-named proposed procedure. This request indicated that the data are largely collected and that the help requested is to examine data rather than design experiments. It was agreed that the Statistics Committee would work with this problem, asking for all possible information regarding the manner in which the data were collected, since it is apparently too late to aid in planning the experimental

ork. This problem is the first problem that the Statistics mmittee has received from other TAPPI committees and herefore should prove of value as an experimental study of w the committee might function.

Book Reviews. Trelfa proposed that abstracts of all papers ling with paper and related subjects (sheet steel, etc.) uld be taken from *Industrial Quality Control*, subject to ap- val by ASQC. The committee will request that this pro- al be activated by direct arrangement between TAPPI *Industrial Quality Control* Editorial Boards. In addition, rcell will abstract those papers dealing with paper and ilar subjects which appear in *Industrial Quality Control* possibly other periodicals, for publication in *Tappi*.

Missionary Work. A list of qualified speakers, both from point of view of statistical background and speaking ity, who might be available to local sections will be pre- ed and sent to local committees. This list will be started Langmaid and circulated among committee members for itional comments. In addition, Purcell will get the ASQC of speakers and their questionnaire.

Application of Control Charts. The subject of application ontrol charts was discussed briefly and it was finally agreed t it would be desirable to have a subcommittee meeting to uss questions of over-all application of control charts to ermaking. The time of this meeting was set for 9:00 . on Tuesday morning, Feb. 17, 1953.

MAYNARD S. RENNER

The committee membership comprises:

J. F. Langmaid, Jr. (Chairman), S. D. Warren Co., Cumberland Mills, Me.
Maynard S. Renner (Secretary), Dewey & Almy Chemical Co., 62 Whitemore Ave., Cambridge, Mass.
Charles Bicking, Research and Development Div., Office of the Chief of Ordnance, Washington, D. C.
Geoffrey Broughton, University of Rochester, Rochester, N. Y.
A. C. Dreshfield, 401 W. Elm Ave., LaGrange, Ill.
William D. Hall, Research Director, Folding Box Assn. of America, 237 W. Madison St., Chicago 6, Ill.
E. R. Hoffman, Hammermill Paper Co., Erie, Pa.
W. A. MacCrehan, Quality Manager, Lord Baltimore Press, 1601 Edison Highway, Baltimore, Md.
Robert L. McCray, Crossett Lumber Co., Crossett, Ark.
T. A. Pascoe, Nekoosa-Edwards Paper Co., Port Edwards, Wis.
John M. Patek, Materials Standards Dept., Eastman Kodak Co., Rochester 4, N. Y.
W. R. Purcell, Quality Control Manager, Brown Co., Berlin, N. H.
P. M. Schaffrath, Oxford Paper Co., Rumford, Me.
F. R. Sheldon, Research and Development Dept., Buffalo Electro-Chemical Co., Inc., Station B, Buffalo 7, N. Y.
O. H. Somers, Western Printing and Lithographing Co., Racine, Wis.
E. Sutherland, Assistant Director of Quality Control, Personal Products Corp., Milltown, N. J.
Richard T. Trelfa, Technical Director, Watervliet Paper Co., Watervliet, Mich.
A. P. Tracy, Assistant Technical Director, John A. Manning Paper Co., Troy, N. Y.

APPENDIX—REPORT OF SUBCOMMITTEE ON "FINISHING ROOM SAMPLING PLANS"

One discussion was held with the paper testing group at the National Bureau of Standards. The plans of our committee were discussed with Mr. Hobbs. The impression was obtained that little consideration has been given in the past by the Bureau to the statistical aspects of sampling plans. However, this contact should be followed up to obtain maximum cooperation from this group because of their long experience in the problems of paper testing.

ASTM Committee D-6 prepared a proposed "Standard Method of Sampling Paper and Paper Products," ASTM -585. This proposal was reviewed by members of ASTM Committee E-11 on Quality Control of Materials. In general, the comments which resulted indicated disapproval of numerous aspects of the proposal. A reply from D-6 indicated a continued disagreement on a considerable area of the proposal. As far as has been determined, this has not been ironed out as yet.

The above kind of situation seems to call for very close cooperation between those who are highly proficient in statistical sampling, such as Harold Dodge, Chairman of E-11 and those who know the paper industry, such as the members of D-6 and of our TAPPI Committee. Through our common membership in both societies, we can attempt to develop a mutually satisfactory approach during our next year's work.

C. A. BICKING, *Chairman*

Structural Fibrous Materials Committee

Edward M. Jenkins, chairman of the Structural Fibrous Materials Committee, has announced the following personnel for 1953–54:

Edward M. Jenkins (Chairman), Johns-Manville Corp.
T. C. Duvall (Secretary), Wood Conversion Co.
V. M. Anderson, Fir-Tex Insulation Board Co.
J. O. Burton, Minnesota & Ontario Paper Co.
A. H. Chamberlain, Bird & Sons, Inc.
G. H. Chidester, Forest Products Lab.
Emile Frederick, Jr., Celotex Corp.
O. W. Frost, Forest Fiber Products Co.
D. L. Gleaves, National Gypsum Co.
R. G. Lacey, Celotex Corp.
W. D. MacKinnon, Donnacona Paper Co., Ltd.
T. R. Naffziger, Northern Regional Research Lab.
J. J. Perot, Flintkote Co.
W. L. Scott, Armstrong Cork Co.
R. J. Shouvlin, Bauer Brothers Co.
A. T. Walton, Simpson Logging Co.

COMMITTEE S-0: STEERING

E. M. Jenkins (Chairman), Johns-Manville Corp.
J. F. Campbell, Flintkote Co.
T. C. Duvall, Wood Conversion Co.
R. G. Lacey, Celotex Corp.

COMMITTEE S-1: NEW PROJECTS AND REVIEWS

J. O. Burton (Chairman), Minnesota & Ontario Paper Co.
T. C. Duvall, Wood Conversion Co.
J. J. Perot, Flintkote Co.
E. J. Reichman, Simpson Logging Co.

COMMITTEE S-2: PAPERS AND PUBLICATIONS

J. F. Campbell (Chairman), Flintkote Co.
E. M. Jenkins, Johns-Manville Corp.
T. C. Duvall, Wood Conversion Co.

COMMITTEE S-3: TEST BOARD FORMATION

R. G. Lacey (Chairman), Celotex Corp.
A. H. Chamberlain, Bird & Sons, Inc.
D. L. Gleaves, National Gypsum Co.
T. R. Naffziger, Northern Regional Research Lab.

COMMITTEE S-4: Drainage Time Testing

J. J. Perot (Chairman), Flintkote Co.
C. E. Hrubesky, Forest Products Lab.
E. M. Jenkins, Johns-Manville Corp.
W. D. MacKinnon, Donnacona Paper Co., Ltd.

COMMITTEE S-5: TRANSVERSE AND DEFLECTION TESTING

J. F. Campbell (Chairman), Flintkote Co.
Wayne C. Lewis, Forest Products Lab.
E. A. Lauring, Minnesota & Ontario Paper Co.
R. H. Neisel, Johns-Manville Corp.

COMMITTEE S-6: WATER ABSORPTION, WATER PENETRATION AND WATER VAPOR PERMEABILITY

A. T. Walton (Chairman), Simpson Logging Co.
V. M. Anderson, Fir-Tex Insulation Board Co.
J. J. Erchul, Pioneer Flintkote Co.
O. W. Frost, Forest Fiber Products Co.
R. D. Ziegler, University of Washington

COMMITTEE S-7: NAIL HOLDING—RACKING TEST

E. J. Jones, Celotex Corp.
T. C. Duvall, Wood Conversion Co.
W. L. Scott, Armstrong Cork Co.
A. H. Chamberlain, Bird & Sons, Inc.
E. M. Cagle, Flintkote Co.

Committee S-8: Light Reflection Measurement

W. L. Scott (Chairman), Armstrong Cork Co.
E. J. Jones, Celotex Corp.
L. R. Sherlock, Fir-Tex Insulation Board Co.
M. C. Miller, Johns-Manville Corp.

Committee S-9: Consistency Measurements of Insulating Board Pulps

A. H. Chamberlain (Chairman), Bird & Sons, Inc.
G. E. Chamberlain, Minnesota & Ontario Paper Co.
R. J. Seidl, Forest Products Lab.
H. M. Sutcliffe, Celotex Corp.

Committee S-10: Test Board versus Handsheets for Board Pulp Evaluation

R. J. Shouvlin (Chairman), Bauer Brothers Co.
F. R. Hyatt, Johns-Manville, Corp.
R. G. Lacey, Celotex Corp.

Water Committee

The Water Committee meeting was held in the Grand Ballroom of the Hotel Commodore at 2 p.m. on Monday afternoon, Feb. 16, 1953, with the following present: A. S. Erspamer (Chairman), H. E. Berg, S. W. Bergen, C. M. Connor, L. L. Klinger, C. C. Porter, R. B. Martin, H. J. Skinner, J. N. Stephenson, A. M. Thurn, J. W. Weidman, N. I. Bearse, and R. W. Kumler.

The status of the questionnaire sponsored jointly by the Water Committee and the Conservation Foundation was briefly discussed by Mr. Bergen of the Foundation. A progress report on the replies received to date was presented by Mr. Bergen at the Water Session on the annual program, Tuesday, February 17. Mr. Bergen, with the assistance of R. T. Bingham, TAPPI, and Harry Gehm, National Council for Stream Improvement, will summarize the results of the questionnaire for distribution to the participants.

The project sponsored by the Water Committee under Research Grant No. 40, Development of a Standard Method for the Determination of Suspended Solids in Mill Waste—A Comparison of Buchner and Gooch methods, was reported on by the chairman. This work is being carried out by The Institute of Paper Chemistry under the guidance of B. L. Browning. Two wastes, kraft mill and deinking, were studied and the data obtained did not show that significant differences are obtained when using the Buchner funnel as compared to the Gooch crucible method. To complete the work, the two methods will be compared in a variety of wastes from different sources and representing different types of operations.

J. N. Stephenson discussed the chapter on Water for the textbook. The chapter is in good shape except for a few loose odds and ends.

A. M. Thurn, Champion Paper and Fibre Co., Hamilton, Ohio, will be the new program chairman for the Water Committee replacing C. M. Connor who regretfully resigned because of the press of other work. It is only fitting to mention here the fine job Mr. Connor did as program chairman as well as his generous offer to help out as a member of the program committee.

C. C. Porter brought up the subject of greater participation of mill men in the various TAPPI programs. It is extremely difficult to get papers from mill men and it seems that management is not completely sold on the idea. N. I. Bearse agreed to take up the matter at the TAPPI Executive Committee meeting to see what could be done.

The Water Monograph was discussed and it was agreed that the Monograph should be brought up to date. Work along these lines will be initiated this year.

There being no further business, the meeting was adjourned at 5:10 p.m.

Committee Personnel

A. S. Erspamer (Chairman)	C. C. Porter
C. L. Anderson	J. J. Priest
L. L. Klinger	H. J. Skinner
R. B. Martin	W. A. Tanzola
E. N. Poor	A. M. Thurn

Program Subcommittee

A. M. Thurn (Chairman)	A. S. Erspamer
C. M. Connor	C. C. Porter

Analytical & Testing Methods Subcommittee

W. A. Tanzola (Chairman)	H. E. Berg

Special Project Subcommittee

E. N. Poor (Chairman)	L. L. Klinger

Water Supply and Treatment Subcommittee

H. J. Skinner (Chairman)	R. B. Martin
H. E. Berg	

White Water Utilization and Waste Disposal Subcommittee

C. C. Porter (Chairman)	J. J. Priest
C. L. Anderson	A. M. Thurn
R. B. Martin	

Authorized Committee Projects

No. 208—Preparation of Routine Control Methods
No. 296—Second Monograph on Water
No. 466—Research Project No. 40. Suspended Solids Determination by Buchner versus Gooch Methods

A. S. Erspamer, *Chairman*

Graphic Arts Committee

The meeting of the Graphic Arts Committee was called to order at 2:40 p.m. Feb. 16, 1953, by Chairman Elliot. The following members and guests were present:

F. D. Elliot, Time, Inc.
F. A. Weymouth, IPI Div., Interchemical Corp.
L. F. Englehart, IPI Div., Interchemical Corp.
R. H. Simmons, Government Printing Office
E. R. Duffie, Sun Chemical Co.
G. Larocque, New York *Daily News*
H. M. Annis, Oxford Paper Co.
R. F. Reed, Lithographic Technical Foundation
Iven Ahrenkilde, Research Dept. of the Graphic Arts College of Denmark
R. H. McKee, Columbia University
E. L. Turner, Jr., Gardner Board & Carton Co.
L. G. Zenter, Gardner Board & Carton Co.
W. Verseput, Robert Gair Co.
J. Ramsbottom, Andrew Jergens Co.
A. T. Luey, Sutherland Paper Co.
C. A. Morton, West Virginia Pulp & Paper Co.

The minutes of the previous meeting were read and approved. Mr. Elliot was selected to succeed himself as committee chairman. Dr. Larocque was chosen as committee vice-chairman. Mr. Morton was appointed as secretary to the committee and as chairman of the subcommittee responsible for the Monograph on Printing Processes.

Dr. Larocque reported that his organization is investigating the stress-strain relationship of newsprint on the printing press and is developing a recording tensile tester. Dr. Larocque stated that he will have a more complete report on this investigation for next year's TAPPI meeting. Dr. Larocque offered to represent the Graphic Arts Committee of TAPPI at the Second International Conference of the Printing Research Institutes in Sweden in June and will submit a report of these meetings to the committee members.

The chairman read a letter from Martin Galbraith requesting a review of practical control testers which would provide adequate information on either surface strength or internal bonding strength of a sheet of paper inasmuch as Mr. Galbraith feels the wax test (TAPPI Standard T 459 m-48) is no of practical use on papers having thermoplastic binders in coating formulations.

Mr. Weymouth reported that the Printing Ink Research Institute is presently making a study of the available surface strength tests and testers which may be usable to replac

the wax test. The committee agreed to offer PIRI its cooperation on the project in arranging for paper samples to be submitted to PIRI and in other ways which PIRI might request. Mr. Weymouth will act in conjunction with PIRI for the committee. A short discussion of the available testers followed in which Dr. Reed outlined the use of the LTF tester.

The TAPPI Printing Monograph was discussed and it was agreed that Mr. Morton would submit a proposed outline of the Letterpress Section of the Monograph to the committee as soon as possible after receiving the material currently in the possession of Mr. Elliot.

A New York meeting was tentatively planned for April

The meeting closed at 4:20.

C. A. Morton, *Secretary*

Chemical Methods Committee

The Chemical Methods Committee met at the Commodore Hotel on Feb. 16, 1953.

Pulp Methods

A large number of pulp methods under the jurisdiction of the Chemical Methods Committee are used rather infrequently and have relatively little importance in evaluating pulp. On the other hand, new methods are needed to evaluate pulps especially for the dissolving industry. It is the hope of the Chemical Methods Committee that more progress will be made in selecting new methods, especially for highly refined pulps. In addition existing methods will be altered so that they will be more serviceable for the evaluation of pulps for the dissolving industry.

A. Chain Length Distribution of Cellulose

Mr. Broughton outlined the exploratory work which he has started to develop as a TAPPI procedure for the determination of chain length distribution in cellulose. He reviewed the available methods for determining the molecular weight distribution in the fractions and suitable methods for fractionating the material. A careful study is being made of the recently proposed ACS tentative method entitled "Chain Length Uniformity of Cellulose by Fractional Precipitation of Cellulose Nitrate." This procedure will serve as a starting point upon which to base a suitable suggested TAPPI method.

B. Disperse Viscosity

Mr. Browning of The Institute of Paper Chemistry reviewed for the committee the work which is being done under his supervision on a TAPPI grant on disperse viscosity. The current investigation is being confined to an investigation of the solvent. This will aid in the selection by the entire subcommittee of the proper dispersing medium.

Mr. Martin stated that the new viscosity method can be completed shortly after the choice of solvent has been made. It was estimated that several months' time might be required. Another problem facing the committee will be the selection of the proper viscometers. This selection will be somewhat easier because of recent work done at the Hercules Powder Co. The results of this investigation were presented as a paper later in the week under the title "Variable Sheer Viscometers for Cellulose Intrinsic Viscosity Determination," by F. H. Wetzel, J. H. Elliot, and A. F. Martin. The entirely new disperse viscosity method might be forthcoming within the next year. It seems likely that this procedure will be jointly sponsored by TAPPI, ACS, and ASTM.

The revision of the present methods, T 206 and T 230, have been postponed temporarily pending the outcome of investigation leading to the entirely new procedure.

C. The Determination of the Accessibility of Pulp

Mr. Broughton outlined briefly the methods used for measuring accessibility (crystalline and noncrystalline fractions) of cellulose. Some recent tests were discussed using the Nickerson's anhydrous formic acid method. Other members of the committee had suggestions to offer on methods for determining accessibility. Mr. Browning stated that work was in progress at The Institute of Paper Chemistry in which this property of cellulose was being determined by a physical-chemical method. The results of this investigation are not complete, but when published may also be of value to the committee in its selection of a suggested method. Mr. Broughton was instructed to draft a suggested method as quickly as it could be determined which of the possible methods would be most serviceable in the evaluating of dissolving pulps.

D. Permanganate Number of Pulp

Lyman Aldrich outlined the work which his subcommittee has done on the revision of T 214. A proposal was first presented to revise T 214 to cover both highly refined pulps and crude pulps. However, it was evident from the subcommittee's work that such a task would be extremely difficult, and that a slightly modified procedure should be presented which would cover pulps up to some arbitrary K number such as 25. For pulps which have a permanganate number just slightly greater than 25 some relatively slight modification will be proposed. For example, the quantity of pulp can be reduced. Other alternatives would be to use correspondingly higher volumes of reagent. For pulps with extremely high potassium permanganate numbers such as semichemical pulps, considerably more basic work needs to be done. The subcommittee encountered considerable disagreement as to the application and interpretation of K number procedures to such pulps. Thus far it has not been established that potassium permanganate numbers can give reliable information on such pulps. It may be that at some later date, when work in cooperation with other committees has been completed, it will be possible to add a modification to cover the determination of K numbers at a very high level. Such a procedure would undoubtedly involve some method of dispersing the sample to eliminate bundles of fibers and shives. The subcommittee was instructed to submit its final recommendation for the revision of T 214, particularly as it applies to pulps having K numbers of 25 or less.

E. Pentosans in Highly Refined Pulps, T 223

Mr. McColley described the success with which a colorimetric procedure for small amounts of pentosans has been applied in his laboratory. The color-forming reagents were aniline and acetic acid and have been the basis of the several colorimetric procedures recently described in the literature. The chairman also explained that the newly published* method for pentosans in highly refined pulps has been used for approximately one year for all routine determinations in his laboratory. In view of the very poor success that almost all the committee has experienced in applying the regular TAPPI method T 223 to highly refined pulps, it was agreed that our committee should take some action suggesting that a colorimetric procedure be tried by those laboratories dealing with highly refined pulps. The chairman was requested to take any necessary action on this point.

F. Alpha-Cellulose in Pulp

The committee had a long and active discussion on the determination of alpha-cellulose in pulp as outlined in T 203. It was finally concluded that a method similar to T 203 should be preserved for historical reasons. Such a procedure has been used for many years in evaluating pulps and therefore should be retained. It was finally agreed that the TAPPI procedure should be revised somewhat along the lines of the present ACS procedure. This would bring about a joint method between ACS and TAPPI and probably ASTM

* O'Brien, A. S., Davis, T. L., *Tappi* 35, No. 11: (1952)

which would be recommended for comparative testing and for historical reasons.

Another alkali solubility procedure will be proposed by the committee patterned after the Scandinavian procedure CCA-8. This determines the actual solubility of pulp in 17½ or 18% sodium hydroxide. The pulp never comes in contact with an alkali of lower concentration. This procedure could then be modified by substituting other concentrations of sodium hydroxide such as 5 or 10%, so that workers in other industries could determine the actual solubility of their pulps in alkalies of different strength. Such a procedure will not be referred to as an "alpha-cellulose" method but will be called an "alkali solubility" standard.

G. The Solubility of Pulp in 1% Sodium Hydroxide

The desirability of revising T 212 to exclude air from the apparatus during the test was discussed. However, very little interest was expressed in T 212. Although a method having a sounder basis could be worked out, such a change would bring about an altogether new level of results and would add confusion to the situation. The method is not considered particularly valuable, and many people who determine the 1% solubility are not able to consistently correlate it with performance. It was therefore decided not to alter the present T 212 unless some branch of the industry could demonstrate that their results correlate with some useful property of the pulp.

II. Methods for Paper and Wood

A. Starch in Paper

Mr. Browning described his recently proposed colorimetric method for determining starch in paper. This was published in *Tappi*, September, 1952. There was much favorable comment in the committee on a proposal to revise the present starch standard, T 419. Jack Harvey of the National Bureau of Standards was appointed to head up a subcommittee to draft a revision of T 419 and give serious consideration to a recently proposed colorimetric procedure described by Mr. Browning.

B. Titanium Pigment in Paper

Methods proposed by Mr. Browning of the Paper Institute and those proposed by the Titanium Pigment Corp. were studied by the committee. The chairman was instructed to select a chairman for a subcommittee to study and revise T 439.

C. Methoxyl Groups in Wood

E. P. Samsel of the Dow Chemical Co. has submitted a report on the revision of T 2, Methoxyl Groups in Wood. He is comparing the TAPPI procedure with the one currently being used by the ACS. Mr. Samsel requested various wood samples which would assist him in reaching final decisions after which he will submit to the committee a revision of T 2.

A. S. O'Brien, *Chairman*

RECENT BOOKS

Paper Year Book—1953. 11th Ed. Edited by Anita Reinig. Davidson Publishing Co., 405 E. Superior St., Duluth, Minn. Cloth, 8½ × 11, 530 pages. $10.

Previous editions of the Paper Year Book have been reviewed in *Tappi*. During the past few years the editors have found it convenient to refer many inquires to this interesting and useful publication for information requested. Although the book is about 100 pages smaller than previous volumes, more than 1200 kinds of paper are mentioned. A better arrangement of text has made the smaller book possible without decreasing its useful contents.

In addition to the customary sections on fine paper, printing paper, coarse papers, and specialties, a new section appears on military packaging. More than 500 individuals assisted in the preparation of the year book.

Papermaking in Pioneer America. By Dard Hunter. University of Pennsylvania Press, Philadelphia, 1952. Cloth, 6 × 9¼, 194 pages. $6.50.

Collectors of Dard Hunter writings will be pleased to know about the availability of his latest work which was prepared under the Rosenbach Fellowship in Bibliography at the University of Pennsylvania. The text is approximately the same as that used in his "Papermaking by Hand in America," a formidable and very expensive publication.

Following two interesting chapters on The Beginning of Papermaking and The Equipment and the Operation of the Early Mills he proceeds to give an account of the papermaking pioneer days in Pennsylvania, Virginia, Massachusetts, and the other original groups of states. A list of the American papermakers (1690–1817) is given.

The Science of Color. By the Committee of Colorimetry of the Optical Society of America. Thomas Y. Crowell Co., New York, 1953. Cloth, 7 × 10, 385 pages. $6.50.

In the United States the standards of the Optical Society of America are looked upon as being authoritative. The present volume prepared for scientists, artists, manufacturers, and students meets the needs of this diversified group. For scientists it is technical with no holds barred, but for the layman, which includes all of us who are not scientists, a large part of the book provides information needed for a proper understanding of this interesting and complex subject.

Chapters include such subjects as: The Concept of Color, Physiology of Color Vision, Sensory and Perceptual Aspects of Color, Radiant Energy, Colorimeters and Color Standards.

Engineers in Ivory Towers. By Hardy Cross. Edited by Robert C. Goodpasture. McGraw-Hill Book Co., New York, 1952. Cloth, 5½ × 8, 141 pages. $3.00.

Hardy Cross is Strathcona Professor of Engineering at Yale University. The present volume consists of a series of interesting and unusual essays on engineering and engineering education in many of its phases including its values, responsibilities, and limitations. Mr. Cross is an unusual person, graduating first in liberal arts, he taught English for awhile then went back to school and became and outstanding civil engineer.

Dictionary and Encyclopaedia of Paper and Paper-Making. 2nd. Ed. By E. J. La Barre. Swets & Zeitlinger, Amsterdam, 1952. Cloth, 6 × 8½, 500 pages. $10.20.

La Barre's revised and enlarged dictionary is welcome. The first edition of 1937 went out of print a few years ago. Most of the text is in English but all terms defined are accompanied by French, German, Dutch, Italian, Spanish, and Swedish equivalents.

The book is the product of more than seventeen years,

luding four years of wartime internment of collecting, omparing, and studying works on paper, its history, and nufacture.

Encyclopedic articles are included on such subjects as ers, sizes, standardization, watermarks, wrappings, and tings.

The lists of sources of information are in themselves a st for any self-respecting paper industry library. These include dictionaries, encyclopedias, directories, ournals, historical works, books, etc.

emical Processing of Wood. By A. S. Stamm and E. E. Harris, Forest Products Laboratory. Chemical Publishing Co., New York, 1953. Cloth, $5^1/_2 \times 8^1/_2$, 00 pages. $12.

The authors, Stamm and Harris, are well known to the p and paper industry, having participated in several PPI meeting programs. The object of the authors was assemble all available information on the subject. ief emphasis is given to the newer processing methods. s written primarily for chemists and engineers.

Among the subjects covered in the book are: The Conuents of Wood; Structure; Mechanical and Thermal operties; Wood-Base Plastics, Pulp and Paper; Pulp ards and Paper-Base Laminates; Cellulose Derivatives; tractives; Wood Hydrolysis; and Miscellaneous Prodts.

andbook of Material Trade Names. By O. T. Zimmerman and Irvin Lavine, University of New Hampshire. Industrial Research Service, Dover, N. H., 1953. Cloth, $7^1/_2 \times 10^1/_4$, 794 pages. $20 (U.S.A.); $22.50 (outside U.S.A.).

The present volume is the second edition, the first edition having been published in 1946. It describes about three times as many materials appearing in the first issue. Three major sections feature the following: (1) alphabetical listing, (2) use classification, and (3) company directory. A new Classification Section has been added giving all the trade names under headings such as Adhesives, Synthetic Resin Base. The Directory Section lists companies, giving the trade names of their products. The book is a must for all purchasing agents and a useful guide to anyone responsible for technology in any form.

Note: Books reviewed in this section may be obtained through the Book Department of The Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

LETTERS TO THE EDITOR

Critical Speeds, Vibration and Roll Balancing

To the Editor, *Tappi:*

The exchange of letters in the March issue of *Tappi* on the subject of critical speeds, vibration and roll balancing and which included your very good letter on that subject has been read by us with interest.

For many years in our sales effort at Rice Barton Corp. we have been trying to get our story across to the paper mill trade that a large part of the success of making a good roll that will balance lies with the important factor of design. We recognize that a paper machine is approximately 75% rolls and that it is essential to construct a roll suitable to meet the operating conditions. It has been our experience, however, that a well-designed roll usually adds up to a higher cost to the purchaser and therefore, in many cases, it is difficult to convince the buyer.

You may be interested in steps that have been taken by Rice Barton to ensure their customers of the very best quality obtainable in all paper machine rolls. About forty years ago, we recognized the tendency toward higher speeds and such things as critical speeds of rolls did exist. At that time no balancing machines were available for our type of work and we built our own which, although rather crude, served us very well. It involved a careful design of the rolls so that they could be balanced. All rolls made from tubes or pipes are made by us in the following manner:

1. In recognition of the fact that all tubes are not perfectly concentric, micrometer readings are taken of the wall on both ends of the body. A mark is made from one end of the tube to the other, marking the light section. The centers of percussion are then calculated and at those points through the wall of the tube, weights are attached on the inside to compensate for the imbalance of the structure.
2. Specially designed heads are then inserted in the tubes with journals attached and the rolls are balanced in our balancing machine. This is done by adding weights in the heads at the end of the roll. Considerable care is exercised in this operation. If rolls are sent to a rubber coverer, they are returned to our shop for a further check in the balancing machine.
3. Of course, the careful selection of the tube or pipe in the first place is required. We use a formula to determine the critical speed of the tube and this is the first principal critical speed mentioned in your letter. This formula is based upon deflection of the finished roll. In checking our rolls in the balancing machine, we find that the first principal critical speed shows up very strongly but we have never encountered any noticeable indication of the two minor critical speeds which you mention. This may be partly due to the steps we have outlined above.

In recognition of the increasingly higher speeds desired by the paper mills today, Rice Barton has recently installed a new roll balancing machine. This machine has an electronic recording device with a stroboscopic light indicator. There is also an indicator to determine the exact centers of percussion. The approximate amount of weight required to balance a roll is also indicated on a meter. This machine has enabled us to reduce the time required to put a roll in balance and will balance a roll properly designed for speeds up to 7000 f.p.m.

This new roll balancing machine is the first installation of its kind among paper machinery manufacturers and we believe that as a result of its use, we will be better able to service our clients. Should you have any desire to see this new equipment of ours, we will be very glad to have the opportunity to show it to you. We would like to invite you to come to Worcester at your convenience.

A. J. Gardner, *Vice-President*
Rice Barton Corp., Worcester, Mass.

EMPLOYMENT SERVICE

Positions Open

P291-53. Technical Salesman. Progressive manufacturing concern desires aggressive individual with several years' paper mill experience. Technical background essential. Requires travel in New York State. Send complete information on education, experience, and salary desired.

P294-53. Paper Chemist for important supervisory work in large research and development laboratory. Prefer Ph.D.

with paper industry experience and good chemical background. Please send details of education and experience.

P295-53. Young Chemist, preferably with pulp and paper training, and with at least two years' experience to take charge of control laboratory of midwestern paper mill. Staff of four. Please state education, experience, and salary expected.

P296-53. Technically trained man, preferably in early thirties for service work in connection with pulp sales office in New York. Applicant must be prepared to travel, visiting converting mills, etc., in U.S.A. Knowledge of usual range of wood pulps required, including understanding of pulp characteristics in relation to end uses for effective liaison between technical staffs in consumers' plants and pulp mills. Replies should state clearly age, training, and all experience leading to the requirements indicated. All applications treated confidentially.

WANTED: RESEARCH CHEMIST

Immediate opening in research and development department of specialty paper manufacturer. Excellent opportunity for young man with initiative and imagination. Experience or background in paper technology and resins desirable but not essential. In first letter give complete resume of experience, age, education, and present salary. Address Technical Director, Hollingsworth & Vose Co., East Walpole, Mass.

PULP AND PAPER CHEMIST

Recent pulp and paper chemistry graduate with wood technology background for trainee position in product development on fiberboard products and desiring eventual position in plant management. Assignment northern Florida fiberboard plant. National company. Send details including age, salary requirements, etc. to TAPPI, P297-53, 122 East 42nd Street, New York 17, N. Y.

CHEMIST WANTED

CHEMIST for Research Department of a Company engaged in the manufacture of cellulose fiberboard, coating compositions and adhesives, located in Western New York. Please submit resume of personal data, education and experience in the first letter. Reply to TAPPI P298-53, 122 East 42nd Street, New York 17, N. Y.

WANTED

Development Paper Technologist

By leading southern manufacturer of high alpha cellulose pulps. Graduate Pulp and Paper Technologist or Chemical Engineer for research development work on pulp and paper specialties.

Applicant should have at least five years' experience in actual operation and technical development of pulp and paper machinery. The knowledge of the manufacture of rag content papers and such specialty papers as filter, absorbent, saturating, creped and others is also desired.

Applicant should include in first letter all personal data including photographs, complete educational and industrial history, also starting salary expected.

Reply to P301-53, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

P299-53. Instructor in Pulp and Paper. Chemical Engineer with education and/or experience in pulp and paper. Opportunity to do graduate work in paper engineering. Age not important. Will consider a recent graduate or an individual retired from active work in the industry. Lowell Textile Institute, Lowell, Mass.

P300-53. Sales Engineer. Opportunity to join well-known established machinery firm. Technical ability and papermaking background necessary. Knowledge of beating and pulping process and equipment desirable. Some sales experience or sales inclination helpful. Must be able to travel in territory. Tell us about yourself in your letter.

P302-53. Well-established company with excellent national reputation desires man to cover paper and allied trades in midwest. Must be thoroughly familiar with paper mill operations. Good paper mill and/or chemical background essential. Please give complete details of qualifications and experience indicating salary expected.

P303-53. Electrical Engineer with some mechanical experience for maintenance work in well-established nondefense plant in New Jersey. Permanent position. Salary open.

P304-53. Paper Technologist with a minimum of 2 years' laboratory and paper mill experience desired by chemical supply company. The position involves the development of chemicals and processes for the deinking of paper, pitch control, coating, etc.

P305-53. Qualified chemist with experience in the manufacture of kraft pulp and kraft specialties for a midwest paper company. Man in his 40's preferred.

Positions Wanted

E198-53. Chemical Engineer, 37. M.S. in pulp and paper chemistry. Eight years' technical and practical experience in insulation board and hard board manufacture, process control, and development work in wood-waste utilization. Desires permanent position in supervisory technical or production capacity, preferably in new development. Prefer West Coast location.

E226-53. Pulp and Paper Chemist. Master's degree from N. Y. State College of Forestry. Three years' experience. Publications. Desires position in paper development work or production.

E227-53. Superintendent-Chemist. Twelve years' practical and technical experience in diversified fourdrinier mills making kraft and blotting specialties, bags, converting. Quality control. Laboratory supervision. Complaint investigation. Now employed. Desires supervisory or assistant's position with progressive firm.

E228-53. Pulp Mill Manager desires new position. Thirty years' experience with northeastern pulp and paper manufacturer. M.S. in chemistry. Four years' experience in research and development of new sulphite pulps. Fourteen years' experience in specialty sulphite pulp mill in technical control and assistant operating foreman capacity. Two years' experience as specialty sulphite pulp mill bleaching and drier operating superintendent. Five years as specialty sulphite pulp mill superintendent. Five years of operating a 180 to 325-ton specialty sulphite mill and a 200 to 250-ton modern unbleached kraft mill as Manager of Pulp Division.

E229-53. Graduate Chemical Engineer now employed desires to change position. Ten years' experience in development and quality control in paperboard and converting; also production experience in graphic arts.

E230-53. Papermaker with a lifetime experience in the manufacture and sale of pulp, paper, boards, containers, cartons, etc., in Great Britain, Canada, and the United States will be pleased to represent a reputable company in the middle west on technical sales.

E231-53. Technical or Research Director. Broad administrative experience in pulp and paper, particularly dissolving grades and viscose. Eight years' research direction for major producers. Proved organizational and technical ability, successful in improving customer relations. Canadian, Ph.D. Age 39, currently directing research but desires increased responsibility. Southern location preferred.

E232-53. Graduate Chemical Engineer. Six years' research experience in pulping, blocking, and related studies. Eleven years' management and engineering experience in another industry. Now employed. Desires supervisory production job combined with technical service.

Note: Responses to Positions Wanted and Positions Open should be sent to the Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Kalamazoo Valley

The Kalamazoo Valley Section held its regular monthly meeting on Tuesday, Feb. 10, 1953, at the Hotel Harris, in Kalamazoo, Mich. Dinner was at 6:30 p.m. 130 members were present.

The meeting was opened by the chairman, Thomas Luey. William Hathaway introduced James d'A. Clark, Consultant, Longview, Wash., the speaker of the evening.

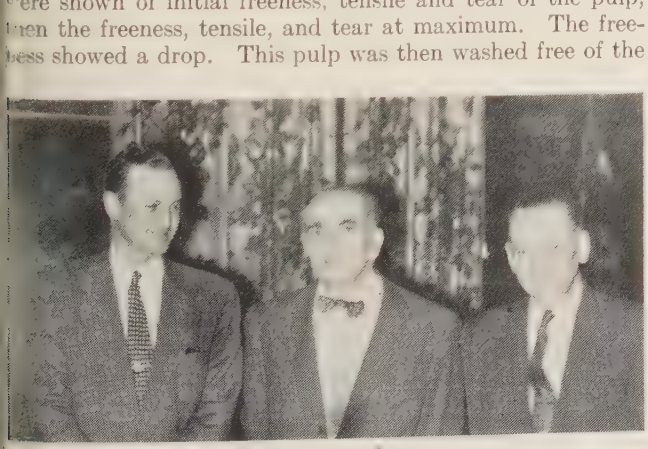
Dr. Clark's subject was "The Beating and Refining of Pulps for Strength Development." He stated that he would limit his discussion to the wet west coast softwood fiber. This fiber consists of a thin outside water-repellent wall, an under-layer of tightly wound stringy fiber, another loosely wound layer embedded in the water-soluble portions of the fiber proper. Under this is the inner layer, similar in composition to the outer wall. The outer wall, though water repellent, is porous and will allow water to penetrate the inner layers of the fiber.

James d'A. Clark,

Only two things can happen to the fiber in the beating and refining process; it can be cut and it can be split, everything that happens to the fiber as described above can be explained in terms of the above two factors. In the beating and refining process the outer skin of the fiber is removed, the windings make fuzz or fabrillae, the water-soluble portions of the fiber go into solution, pushing up the fabrillae giving so-called hydrated pulp. The splitting and cutting of the fiber give more water-reactive surfaces, hence more fibrillation and better cohersion.

The characteristic hardness of the sulphate fiber is explained by the fact that the inner layer has been dissolved to a greater extent than sulphite fiber so takes more cutting and splitting.

He spoke also of the value of freeness measurements, slides were shown of initial freeness, tensile and tear of the pulp, then the freeness, tensile, and tear at maximum. The freeness showed a drop. This pulp was then washed free of the fine debris. A recheck of the washed pulp showed the original unbeaten freeness but retained the developed beaten strength. Therefore, freeness is more a measure a fiber debris than actual fiber hydration. Specific surface measurements and fiber length classification were better. Some mention was also made of the zero span tensile tests of unbeaten pulp as a good measurement of pulp quality.



T. Luey, Sutherland Paper Co.; Albert Kner, Container Corp. of America; and Harvey Hartman, American Boxboard Co.

Meeting of March 19, 1953

The Kalamazoo Valley Section and the Michigan Division of the Superintendents Association held their "Graphic Arts" Meeting on Thursday, March 19, 1953, at the Hotel Harris in Kalamazoo. 140 members were present.

The meeting was called to order by Chairman Thomas Luey. The speaker, Mr. Kner of the Container Corp. was introduced by Reginald H. Hurst. Mr. Kner's subject was "How to Make Better Packages."

Mr. Kner gave a talk based on a series of slides illustrating his points. Many things go into the package—the board, package construction, the art work, and the pointing. All the individual operator sees is that part of the work in which he is concerned, there has to be some coordination. Also involved is the public reaction, the good art work may be wasted by poor design. He described a few of the tests used to determine the effect of the package on the consumer. One was the rapid showing of a group of packages and asking which one the observer saw. Another was an instrument for determining how long the eye rested on a given package. Also there is a device for determining the best angle for package exhibition.

Salesmanship is very important on everyone down the line, to the printer, to the package salesman, and the ultimate customer. To do this, the designer sometimes has to go even to the re-design of the inner label on the product. In conclusion, the chief items in the successful package are the message to be given, the color of the package, the surroundings of the package, the space available, the type used, and the printing process used.

JAMES A. DEAN, *Secretary*

Lake Erie

The Lake Erie Section met at the Carter Hotel, Cleveland, Ohio, on March 20, 1953. J. B. Whitlock of the Armco Steel Co., Middletown, Ohio, was the principal speaker. His subject was "Development of a Maintenance Program for the Armco Steel Co."

Mr. Whitlock explained in his talk how Armco has set up a system of inspection and a training program for their inspectors and engineers which has reduced its maintenance costs and increased its production. The key to the success of the company's maintenance program has been the use of on-the-job trained men. An outline of Mr. Whitlock's talk follows and is followed by a record of the discussion:

I. Reasons for a Sound Maintenance Program
   - A. 1929–50—national production/man-hour increased from 570 units to 800 units = increase 40%
   - B. 1929–50—kw.-hr. used in industry increased from 43,000,000 to 140,000,000 = increase 230%
   - C. 1929–50—kw.-hr. used per employee increased from 5000 to 12,000 = increase 140%
   - D. 1943–51—annual kw.-hr. per worker man-hour from 3.62 to 6.60 = increase 82%

E. Machinery replaces manual labor
F. Continuous operation must be delay free
G. Maintenance expenditures must be controlled and reduced

II. Development of Armco Program
A. Organization
1. Assigned
2. Shops
3. Power
B. Inspection system—key of program
1. Method employed
2. Results obtained
(a) Repairs made before failure
(b) Repairs intelligently scheduled
(c) Foreman a manager
(d) Crews constructively engaged
(e) Inspector-foreman training ground
(f) Examples
C. Material application
1. Why
2. Examples
D. Lubrication
1. Survey
2. Training
3. Organization
E. Prime mover inspection
1. Why
2. Program
F. Shop scheduling
1. Method
G. Training
1. Shops
2. Assigned
3. Specialized
H. Records
1. Equipment logs
2. Value

III. Results of Program
A. Increased production
B. Delay reduction
C. Cost control
Assigned labor—total dollars up, 1.78%, rate up 13%
Repair labor—total dollars up, 1.79%, rate up 13%
Repair material—total dollars down, 4.45%
Special repair—total dollars down, 3.47%
Total maintenance—dollars down, 0.97%

Question: In your training program what arrangements are made concerning the employee leaving the company?

Answer: We have no arrangements for that but we do promise a full mechanic's rating after completion of the course. There are three mechanic's ratings A, B, and C. The second two are only obtained on seniority.

Question: Do your craftsmen belong to the union?

Answer: We do have a union but generally the craftsmen are not union men.

Question: Do you think this type of maintenance program would be of benefit to smaller units?

Answer: Yes, we operate three small divisions of 200 to 225 employees. Here we do not have a lubricating engineer or material engineer. We do have an inspector and a limited training program. In these units the foreman doubles in brass as an inspector.

Question: Maintenance work usually has peaks and valleys—how do you overcome this—by outside help?

Answer: No, the engineering and maintenance departments handle all this work. Our inspection system has to a large extent eliminated the peaks and valleys.

Question. Do inspectors make reports on all equipment whether they need repairs or not?

Answer: Yes, they do.

Question: Does each turn foreman make up a log for his turn?

Answer: Yes, because we do not want to overburden the maintenance foreman.

Question: What text do you use for the course on lubrication?

Answer: We made our own text for both the fundamental and advanced courses. One engineer was sent to take the lubrication course at M.I.T. He then wrote our advanced course from knowledge gained there.

Question: On a shop order to you make an estimate before the job is done?

Answer: We only estimate the man-hours not the dollars. Man-hours are our main concern rather than dollars. A record is kept of all jobs done so that they can be used for estimating future jobs. We do not estimate the material ahead of time—only the labor.

Question: Have you a breakdown between experimental and regular maintenance?

Answer: Yes, experimental work is checked by the engineering department. They estimate it and decide whether to give it to the Research Department.

Question: How are your inspectors distributed?

Answer: There is a different inspector for each individual department.

Question: What type of records do you have for your equipment?

Answer: We have a log system. All repair work is noted—including where, when, how, and what was done. Also where the equipment was purchased and how much it cost. We use an I.B.M. machine in connection with the log system. There is an advantage to this type of system because it tells what has been done and what should be done.

Question: Where is the log kept?

Answer: In each department's office. All data are kept to a minimum.

Question: How small a job is entered in the log system?

Answer: Such jobs as replacements of parts even if it is only a few bolts. However, minor adjustments are not entered. The amount of time used is kept for each repair job.

Question: What kind of a stock do you have, to take care of the repairs that come up?

Answer: We carry many spare parts in stock; the amount is determined from past experience and an estimate of what may possibly go wrong in the future.

Empire State (Metropolitan District)

About 70 members and guests were present at the March 10, 1953, dinner meeting of the Metropolitan District, Empire State Section, held at Fraunces Tavern in New York City.

Routine business and announcements were as always quickly disposed of. Chairman Paul Haggerty brought up two minor changes in the articles of organization which were suggested by the Empire State Section Executive Committee and these were approved at the meeting. A nominating committee was appointed consisting of W. R. Willets, chairman, and E. J. Monahan and P. L. Talips to present a slate of officers for the coming season. The April 14 meeting will be a panel discussion of odor and taste in packaging with L. D. Cartwright of Foster D. Snell, Inc., as moderator while the May 12 meeting will be Ladies Night at which D. V. Lowe of the Lowe Paper Co. will describe his European experiences of 1952.

C. G. Landes the program chairman then introduced F. H. Lincoln, Jr., of Time, Inc., who spoke on "Properties Desired in a Machine Coated Sheet for Magazine Printing." Mr. Lincoln based his talk on *Life* Magazine. He mentioned that seven different suppliers made the paper for *Life*, and although the sheets varied in composition, they all had to pass rigid specifications on end use in relation to mechanical performance and printability. Running at high speeds with temperatures up to 350°F. in the drying section, the paper is always under terrific tension. One of the best tests the found to measure the over-all mechanical performance is the Elmendorf dry-tear test.

Although a sheet apparently meets all specifications trouble can still be encountered from wrinkles in the paper, or from telescoping rolls or other defects not apparent before unwinding. The moisture present in the paper is another important factor. Excess moisture can cause blistering when it expands at high temperatures. One of the big troubles in high-speed printing is web breaks. These may be due to fiber cuts, calender cuts, slime spots, or a number of undefined defects. A web break takes about 20 min. to repair, and at present in printing *Life* there are about 2 hr. down time per 100 rolls of paper. Work is constantly being done to reduce this figure.

There are five important sheet properties that are essential to obtain good printing at high speeds. These are levelness, smoothness, compressibility, resiliency, and ink receptivity. The importance of each factor was discussed. Gloss itself is not an important factor, but only insofar as it is related to smoothness. A sheet with lower gloss may have better smoothness than a high gloss sheet. Other important factors

pick, opacity, and brightness. Once the standards for lity have been set, uniformity is most important. It is ch better to have a sheet of uniform average quality, er than one that jumps from average to high quality and k to average. Other printing troubles may be caused by ty plates, ink, worn-down packing, or the press operator, inevitably the trouble is blamed on the paper. In order nderstand the problems of the printer, the papermaker ld educate himself on printing.

Mr. Lincoln illustrated his talk with a number of examples ood and bad printing.

The second speaker was E. V. Morris of Henry Linden-er and Sons, New York City, who spoke on "The Job ermines the Paper." Mr. Morris described some of the blems that the printer is faced with. He has to handle a variety of papers from glassine, which is a very nonabsor- sheet, to blotting paper, which is very absorbent. One he greatest new developments in the paper industry has machine-coated papers. This development has opened field for color printing, and more and more color printing ing used for magazines and advertising.

elling the right paper for the right job is the paper mer-nt's first duty. To sell any paper but the right paper is sservice to the customer. End use is always of prime portance and cost a definite consideration. Mr. Morris ussed and demonstrated many examples where the paper chants picked a special paper for a particular job.

is often very important for a printer to let the paper mer-nt know what is going to be done to a paper after printing. ne case a whole order was ruined because the paper mer-nt did not know the sheet was to be varnished and there-re supplied the wrong paper.

Various types of papers have basis weights based on differ-nt dimensions, but by converting to equivalent basis weight is often possible to interchange grades. The paper mer-ant must be fully aware of the possibilities of substitution.

After his talk Mr. Morris ran a contest in which he distrib-ed four folders containing various types of paper and asked fferent people to identify them. The winner who identi-ed the greatest number of sheets was Jack Rice of the Lowe aper Co. who won a large layer cake for his efforts. The her participants also were awarded prizes.

L. E. Georgevits, *Recorder*

mpire State (Eastern District)

The Eastern District of The Empire State Section met at ilfrank's in Glens Falls, N. Y., on March 19, 1953. John rocker of the Sandy Hill Iron and Brass Works introduced e speaker, Gordon B. Shattuck, Manager of Supply for the rathmore Paper Co., West Springfield, Mass., whose sub-ct was "More New Patterns." Mr. Shattuck's remarks llow:

We papermakers in the Northeastern states are now faced with me new ideas and new competition—from the South.

Within the last few years, the geographical picture of our dustry has undergone a radical change. Following develop-ent of processes for using the fast-growing woods of the Southern tes, a tremendous development of a new Southern paper dustry has taken place. New mills have been erected in eorgia, Florida, Tennessee, and Alabama—all with wide ma-ines, high-speed machines, for volume production. The high t of these mills has been carefully balanced against their high fficiency of production.

In our Northeastern states we have some 134 paper mills in the e paper group. Our tonnage is not large; but we are the iginal American paper industry; our mills are the chief support thousands of workers and many entire communities; our mills present a substantial part of the industrial backbone of the rtheast. Move our mills to the South, and the resultant dis-ption would be catastrophic.

Every additional paper machine put into production in the outh represents very real competition to our Northeastern in-dustry.

Are we so inefficient that we must die? Must our mills be superseded by the more efficient, better planned plants of the South?

Some of us may die. Some of us may be unable to justify our continued existence under this intensified competition. But if that happens—we have no one to blame except ourselves.

What is the answer to our problem? The solution will be varied. But I suggest that part at least of the over-all solution must be: that we must diversify our products, and go farther into the specialty paper field. Further than that, we must develop new papers that will be so unique and useful that they will create their own demand.

I point, briefly, to a few specific instances where some of our Northeastern mills have developed new and useful products.

The thinnest paper in the world is made by the Stevens Paper Mill, Inc. and is used for the dielectric spacer in electrical capacitors. The paper is a precision product: its thickness two ten-thousands of an inch.

Premoid Corp. has been a leader in the "synthetic leather" industry. Their products are used for sock linings for ladies' shoes, for belts, luggage, purses, for wall coverings. The line of distinction between paper, rubber, leather, and glass is becoming more and more indistinct, new products bridge the barrier between one and another.

Strathmore Paper Co. make a specialty paper having a duplex color, light on one side, dark on the other, and with a colored deckle edge.

The Fonda Plate Co. has recently marketed plastic-coated paper plates, printed with attractive designs. No more soaked and soggy plates!

These unique products are only a few of the many—they represent a few of the successful achievements of some of our Northeastern mills. These papers, because their specifications are so exacting, will for a long time to come, be in the province of the smaller producer. The illustrations are merely an indication of the general direction in which many of our mills will have to move—if they are to stay abreast of the times and find their proper place in tomorrow's competitive order of things. They will have to make the equipment flexible to produce a variety of products; they will have to make an investment in technical personnel; and they will have to employ every modern tool for the control of process variables.

Empire State (Central District)

The April 3 meeting of the Central District of the Empire State Section was held at the University Club, Syracuse, N. Y., with 68 attending. H. D. ("Doc") Cook presided as chairman.

A nominating committee for next year's officers was appointed and consisted of Harold Simons, Durward Geffken, and Fred Sommerville. This committee will report at the next meeting.

Those present were reminded that next meeting will be in honor of the senior class of the Department of Pulp and Paper Technology of the College of Forestry. Mr. Macdonald will be the guest speaker of the evening.

The technical program was presented by Fred Sommerville of the Armstrong Cork Co., Fulton, N. Y., who talked on "Fibers and Polarized Light." His investigation was concerned mainly with identifying synthetic fibers in waste rags intended for use in manufacturing saturating felt. The talk was illustrated with numerous Ansco color slides made by George Adams.

S. E. Church, *Secretary*

Empire State (Northern District)

The Executive Committee of the Northern District of the Empire State Section met before the April 9 meeting to accept the slate of officers for the 1953–54 season from the Nominating Committee. Chairman Richard A. Premo presented the slate of officers to the membership. The elected officers for the 1953–54 season are: chairman, James D. Parmele, St. Regis Paper Co., Deferiet, N. Y.; chairman-elect, Sheldon Young, National Paper Products Co., Carthage, N. Y.; treasurer, John H. Treadwell, Treadwell Supply Co., Watertown, N. Y.; secretary, Richard J. Murtaugh, St. Regis Paper Co., Deferiet, N. Y. In addition to the officers the Executive Committee consists of John Cleary, St. Lawrence Paper Corp., Norfolk, N. Y., Morris Myers, William

R. J. Murtaugh, St. Regis Paper Co.; R. E. Fang, Westinghouse Electric Co.; J. D. Parmele, St. Regis Paper Co.; S. E. Franklin, Westinghouse Electric Co.; R. A. Premo, Gould Paper Co.; and John H. Treadwell, Treadwell Supply Co.

Garlough, Knowlton Bros., Watertown, N. Y., and the retiring chairman, Richard A. Premo, Gould Paper Co., Lyons Falls, N. Y.

S. E. Franklin, Consulting Engineer, Westinghouse Electric Corp., discussed the various types of electric drives used for paper machines. He explained in readily understandable language the intricate workings of each drive system. He illustrated his talk with slides. An interesting prop used to convey his thoughts to his audience was a water flow to represent the control of the flow of an electric current for the drives.

During a question-and-answer session Mr. Franklin responded to questions on the reasons specific types of equipment are used on the paper machine drives; the electrical systems used to accomplish a given job and electrical means to control tension on the paper at the winder.

RICHARD J. MURTAUGH, *Secretary*

Lake States

As previously reported in the March issue of *Tappi*, F. A. Guba of The Carpenter Steel Co. was the speaker at the meeting of the Lake States Section which was held at the Conway Hotel, Appleton, Wis., Jan. 13, 1953. The text of Mr. Guba's speech follows:

Corrosion in the Pulp and Paper Industry

F. A. Guba

THE pulp and paper industry challenges the ability of the entire range of stainless steels to combat corrosion. To intelligently put the various analyses to work properly, a general concept of the corrosion picture is necessary.

Stainless alloys have a multipurpose use from extreme heat to extreme cold, from high-strength requirements to weight saving, and run the gamut of the corrosion field from atmospheres to heavy acids.

We divide this versatility of applications into the four cardinal qualities of stainless steel:

1. High strength weight ratio—its greater ultimate and yield, allowing for much thinner sections with corresponding savings in weight, eliminating dead weight losses so important in reducing power consumption on moving parts.
2. Its corrosion resistance, the principles of which we expect to be the major topic of our discussion in this meeting.
3. Heat resistance—giving us a wider range of scaling temperatures and better creep values for strength at continued or short-time periods at such temperatures.
4. Low-temperature properties, in which the austenitic grades give excelling impact values at temperatures as low as 300°.

All of these qualities, except possibly low-temperature applications, are prevailing problems in equipment for manufacturing pulp and paper. When properly applied they insure economical use of a costly and critical material and a labor-saving value on account of less frequent replacement.

Let's look at the make-up of these alloys. The main constituent is chromium, 12% or more, agreed by most authorities as being necessary to impart the required protection. Chromium is a protector of metals which has the power of instantly developing an oxide film on contact with oxygen in the air or liquids which surround it. This film is remarkably resistant to chemical and mechanical attack. Its protection is not only on the surface, as would be with a plated surface, but also extends entirely through the metal, making it effective as long as the material lasts. This is the quality of retarding corrosion which is found in so many applications where stainless steel is used for long service life. This is the type of corrosion resistance which the chrome-nickel-iron alloys are dependent on for service life.

The chrome-nickel-iron alloys have more than simple oxidation resistance, not only on account of the nickel content, but also due to the fact that with sufficient percentage of alloying elements these steels are austenitic in their crystalline formation. This austenicity has a beneficial effect on the physical properties and also enhances the corrosion resistance, giving a uniform resistance to over-all types of corrosion in services that are more than simply oxidizing in their corrosive attack. Since the chromium-fortified alloys are mainly used for corrosion resistance to withstand oxidation attack, it appears that this is the first qualifying fact to be established.

If oxidizing conditions are prevalent, a chrome-fortified alloy is indicated as being necessary, the per cent of chrome content being dependent on the extent of the oxidation resistance required.

If a reducing condition is prevalent, a different trend of thinking is necessary. A material of different alloying materials, which in themselves are resistant to such types of corrosion, will be required. Many of these are not stainless steel alloys. These are conditions which are confronted in the presence of halogen ions as shown on the following chart.

Now, let's carefully check our course from the information at hand and determine the road to take.

In solving our problem we have to decide what kind of corrosive action our metal must withstand—if it is required for an oxidizing condition, or is it because of reducing conditions, causing an intensive pin-point attack. For various reasons of heat, strength or otherwise, a metallic material is desirable. We first look to ordinary carbon steel which, in so many chemical applications, is not sufficiently protected by its oxide to be acceptable. Therefore, we must look further for protection which can be supplied by the chromium-oxide surface of the various stainless alloys. Where the attack is weak or where intermediate heats without chemical attack prevail, the 5% chromes perform a suitable function but, if mild chemical attack is prevalent, a 10/12% chrome

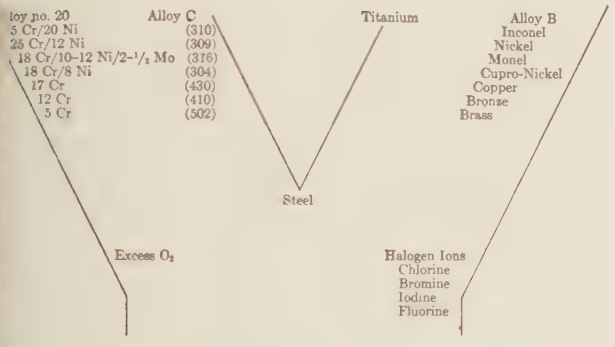
R. A. Premo, Gould Paper Co.; G. V. Rittenhouse, Virginia Smelting Co.; J. D. Parmele, St. Regis Paper Co.; Chas. Mather, Carthage Paper Makers Inc.; W. F. Lukenbach Jr., Virginia Smelting Co.; J. H. Treadwell, Treadwell Supply Co.; and R. J. Murtaugh, St. Regis Paper Co.

F. A. GUBA, Alloy Tube Div., The Carpenter Steel Co., Union, N. J.

...n be very effective. However, we find these alloys, too, ...e many drawbacks in fabrication so that we recommend a ...imum of 17% chrome (type 430) as being best for fabrica... and the beginning of satisfactory corrosion resistance ... many chemicals such as nitric, acetic, picric acids, the ...ious potassium chemicals, and various common everyday ...erials such as carbon monoxide gas, carbonated water, ...ic acid, and many others.

However, our complex requirements for industry, calling ... the use of many more deadly corrosive materials, force ... to go to higher alloy content for protection and we next ... sider the chrome-nickel-irons having all the protective ... face condition of the chrome alloys, and the increased ... stance of the nickel, the moly, or higher quantities of both ...ome and nickel alloy as in the case of 309 and 310.

In the case of 316 the additional alloying element of molyb... um gives increased resistance to over-all corrosion, as well ... additional resistance to concentrated attack, causing pit... e corrosion frequently associated with the localized reduc... condition sometimes found in halide-containing materials. ...se alloys are austenitic in character, are excellent for ...icating—rolling, bending, swaging, flaring, etc., and resist ...ide variety of organic and inorganic acids as shown in the ...osion tables put out by the various manufacturers of ...nless steel products.



Following up the left side of the Y, we come to alloy 20 and alloy C. These alloys are for sulphuric acid resistance and, in addition, alloy C is more universally resistant to the hydrochloric free chlorine and acid solutions of ferric and cupric salts.

It should be stated that starting at the base of the Y the cost of the various materials increases rapidly as you travel upward, shown in a later chart where an effort has been made to show relative costs of tubular products made from various stainless steels.

The right fork of the road, or Y, is concerned with such materials as are best for the reducing action of such halogen acids or salts in an ionized state. Since halides of chromium are soluble in water, a chromium-chloride gives none of the protection or passivity that an insoluble chrome-oxide provides and is certain to cause trouble when using stainless steel as a corrosion-resistant material for these conditions.

Under such conditions, it would appear more advisable to use copper or nickel base alloys for the varied types of resistance required. We arrive at Carptenter alloy B, which we make from Hastelloy strip which has long been used by designers for the work of the reducing conditions encountered. It is excellent for boiling hydrochloric, wet hydrogen chloride gas, and also has excellent resistance to sulphuric acid.

Titanium, a newcomer in the field, is rapidly proving its ability to resist corrosion in the fast company of the four higher-quality materials.

So much for the kinds of corrosion. In addition, there are five distinct types of corrosion: (1) general corrosion, (2) galvanic corrosion, (3) pit-type corrosion, (4) intergranular corrosion, and (5) stress corrosion.

General Corrosion. When the material is evenly attacked and the material loss is uniform over the entire surfaces exposed, we say general corrosion is responsible. It is easy, in such cases, to evaluate the life of a piece of stainless equipment by using the following formula:

$$\text{i.p.y.} = \frac{\text{weight loss/unit time} \times 1 \text{ yr.}}{\text{density*} \times \text{exposed area}}$$

$$\text{i.p.y.} = \text{inches penetration per year}$$

$$\text{service life} = \frac{\text{thickness} \div \text{safety factor}}{\text{i.p.y.}} \text{ or } \frac{\text{thickness}}{\text{i.p.y.} \times \text{safety factor}}$$

Galvanic Corrosion, common to all metals, is brought about when two dissimilar metals, joined together, are immersed in a liquid capable of carrying electric current. This closed electrical circuit causes electric energy to flow through the electrolyte from one metal to the other causing more rapid corrosion, by the solution of the metal which is regarded as least noble and which becomes anodic under this condition.

Galvanic Series of Metals and Alloys

Direction of Attack

Corroded end (anodic, or least noble)
- Magnesium
- Magnesium alloys
- Zinc
- Aluminum
- Cadmium
- Steel or iron
- Cast iron
- Chromium-iron (active)
- 18–8 Chromium-nickel-iron (active)
- 18–8–3 Chromium-nickel-molybdenum-iron (active)
- Carpenter stainless no. 20 (active)
- Lead-tin solders
- Lead
- Tin
- Nickel (active)
- Brasses
- Copper
- Bronzes
- Copper-nickel alloys
- Silver solder
- Nickel (passive)
- Chromium-iron
- 18–8 Chromium-nickel-iron (passive)
- 18–8–3 Chromium-nickel-molybdenum-iron (passive)
- Carpenter stainless no. 20 (passive)
- Silver
- Graphite
- Gold
- Platinum

Protected end (cathodic, or most noble)

In checking with the table showing the galvanic series of metals and alloys, we find that copper corrosion would be accelerated when coupled with silver or gold. Or stainless steel in a reducing liquid with copper would show accelerated attack since the stainless steel would be active and on the anodic side of copper. If a small part of one metal is to be used in an area of contact with a metal of much larger area, the smaller part should be cathodic so as to weaken the cell action

Let us explain that stainless is active in the presence of any combination of chemicals which are reducing and do not allow the formation of an oxide film. Likewise, stainless is passive when the surface of a stainless steel part has developed a protective oxide film. Treating stainless steel in a passivating solution will accelerate the formation of the film. A 15 to 20% nitric acid solution is most frequently used for such passivation.

Pit-Type Corrosion. This can be expressed as an accelerated attack in individual spots. Naturally a reducing agent at that spot destroys the film and attacks the surface of the metal, creating an active and passive area in the same piece

* Density of stainless steel = 0.29 lb. per cubic inch.

of metal. Such a condition accelerates the attack on the active area, creating deeper and deeper surfaces acting like a miniature cell of galvanic corrosion. One of the ways of combating this is to select a steel having a resisting alloy combination, such as molybdenum, which eliminates much of the pit-type attack in 316, 317, and Carpenter no. 20.

On examination of many failures due to pitting attack, it has been noticed that frequently this failure is induced by overlays of saturated scale, adhering particles of lint or other substances, eliminating the formation of the protecting film, and which are very potent on the active surface of the steel under such oxidizing obstructions.

Intergranular Corrosion. In the fabrication of equipment or fluid lines of various austenitic alloys of stainless steel, this is one of the foremost causes of attack. At certain temperatures, usually between 800 and 1600°F., the carbon precipitates and migrates to the grain boundaries and a large portion of the chromium at the grain boundaries and adjacent zones combines with the carbon to form chromium carbides. If left at heat for a sufficient time, this combination could proceed to as high a ratio as 17 chrome to 1 carbon. This leaves the grain boundaries deficient in chromium and under sustained corrosive attack, the steel literally disintegrates into separate grains. Under this condition the steel usually has a dead sound instead of a metallic ring when struck with a metal object. The extent of the precipitation of carbides is dependent on time and temperature. Short times at temperatures described above, as in welding, would produce less precipitation than long operating periods. At the same temperatures, likewise, lower carbon content, being more sluggish in this precipitation, would be more effective in eliminating this type of corrosion, and the degree of intergranular corrosion is likewise dependent on the type of corrodent.

It would be excellent, at this moment, to discuss ways of correcting such precipitation of carbides and eliminating intergranular corrosion. If the piece has been wholly or partially subjected as described above, a heat treatment of quenching rapidly from temperatures between 1800 to 2000°, depending on the analysis, down to 800° or lower, is essential. This treatment again re-dissolves all precipitated carbides, releasing the full chromium content for complete corrosion resistance and putting all carbon back in solid solution.

When the piece to be treated is too large, other alloys containing titanium, columbium, or sufficiently low carbon such as 0.03 max., will prevent such intergranular corrosion conditions. 321 and 347 (when available) will form titanium or columbium carbides when under long-time temperature conditions, and allow full chromium protection without any treatment as described above.

Low carbon, 0.03 max., when used for welding, protects sufficiently on account of the short time at heat and the sluggishness of low carbon to combine with such small percentages of chromium as to be ineffectual in lowering the corrosion resistance in the grain boundaries.

Stress-Type Corrosion. Of all five types of corrosion, we know least about this type. We do know, however, that when chlorides are present with stressed conditions in the metal, a transcrystalline crack develops of rootlike formation. These stresses have always been tension stresses and only apply to the austenitic types of steel. This condition can be overcome by using a ferritic type of stainless of sufficient corrosion resistance which resists such transcrystalline attack. Such types as 430, 443, and 329 serve admirably for such conditions.

430 will resist sulphate liquors, 443 will resist mixed acids, and 329 has been exceptionally good to resist sulphite liquors as well as showing excellent resistance to stress corrosion since it is more ferritic in nature than austenitic.

This completes our discussion on the five types of corrosion and on the four cardinal reasons for using stainless steels. Keep in mind that to get the best results from any of these steels, cleanliness is important. Keep any deposits of product from scaling on the surface. Do not have crevices where stale liquids or product can lurk, use smooth surfaces to prevent accumulation of fibrous, viscous, or granular products. The smoother and the cleaner the surface, the less corrosive the attack. A new branch of the pulp industry, the manufacture of yeast, a part of the reclamation process, can well use the high polished surfaces which stainless can give to eliminate any bacteria growth detrimental to the product.

We know that you are interested in the comparative costs of these materials and the chart below gives such information.

Nickel content, %	*Type*	*Comparison basis (approx.)*
0	430	84
10	304	90
0	443	96
12	321	104
4	329	108
12	347	110
13	316	116
12	309	118
20	310	128
29	Carpenter 20	204
60	Carpenter B	396
55	Carpenter C	412

If you compare this chart with the previous one, you will see that the cost and corrosion resistance are very closely interwoven. You get so much corrosion resistance for just so much money. All comparisons made were relative to 1 in. by 16 gage base prices. It is interesting to note that 329 is 8 points lower in cost than 316, and that 443 only slightly higher (6 points) than 304. It is also very noteworthy that good general protection can be had and still conserve nickel which is a very critical material at this time.

Equipment	*End use*	*Suggested*
Sulphur burners	Flue gas (SO_2) collector	Suggest Carpenter no. 20 (cast material, brick and lead-lined steel formerly used)
Coolers	SO_2 cooling pipes	Carpenter no. 20 (account of condensation of gases, if gas contains excess oxygen, H_2SO_4 results)
Battery room fans	Blow SO_2 gas to bottom of tower	Carpenter no. 20 —same as above
Absorption towers	Pipe lines used to pipe water or weak acid to top of tower	304-309-316-329
Pressure absorbers	For higher concentration of sulphite liquors	317-329
Storage tank	Lines from tower to storage tank and also to digesters	304-316- no. 20
Digester	Mitscherlich system steam coils	316-329
Heater	Circulating system	316-317-329-no.20
Relief lines	Pressure vent line from top of digester	304-316
Recovery systems	Relief cooler	304-316-329
Evaporators	First and second effects	430-304
Heat exchangers		304-443-316

From this we conclude that there are substitutions covering both economy and critical materials. In many of the applications where 304 was previously used, 430 seems to do a good job. In the kraft mill, 430 has proved itself for evaporator tubes, one installation that we know of having been in service 11 to 12 years and another one 4 to 5 years. In

eden 430 has been used for many years for this application. Type 443 can substitute frequently for 304, 347, and 321. applications where it is equal to 304, it can be used in sitizing temperature ranges without precipitation of carbides, eliminating use of 347 or 321.

Type 329 can supplant 316 in many instances. It has given excellent results in sulphite heaters and since it is ferritic in structure will not be vulnerable to stress corrosion as can be the case with 316, 309, 310.

There are, however, many applications where drastic corrosive conditions require the highest resisting materials and we offer herewith a summary of applications of various analyses for different applications.

New England

The New England Section met at the Roger Smith Hotel, Holyoke, Mass., on March 20, 1953. H. W. Knudson of Hollingsworth & Vose Co., East Walpole, Mass., presided as chairman. George Soyka of Byron Weston Co., Dalton, Mass., was program chairman.

Mr. Soyka, representing Albert E. Bachmann of Missisquoi Corp., Sheldon Springs, Vt., presented Mr. Bachmann's criteria of an Ideal Routine Control Test. These are as follows:

1. Useful accuracy and reproducibility.
2. Large enough effective range to distinguish essential differences clearly.
3. Capable of expression by a number rather than by general observation.
4. Expressible in mill language units.
5. Must measure a critical use requirement property.
6. Must tie in with complaint and operational experience.
7. Short enough in procedure to get relatively quick results.
8. Short enough to permit making several tests.
9. Product of extensive research to assure being best of alternatives available.
10. Must be in essential agreement with operational observation.
11. Must be more reliable and selective than observations.
12. Not dependent on personal judgment.
13. Calibration of testing equipment must be simple and definite.
14. Reliable and selective enough so we can bet thousands of dollars on it.

The principal speaker was E. C. Harrington, Manager of Industrial Statistics, Monsanto Chemical Co., Springfield, Mass., who presented a paper on "Increasing the Efficiency and Economy of Experimentation." Mr. Harrington's paper follows:

Increasing the Efficiency and Economy of Experimentation

Edwin C. Harrington, Jr.

WITHIN the last half dozen years there have been many convincing papers (*3*, *4*) and technical discussions demonstrating the tremendous advantages of designing experiments so that they would not only provide the information originally sought, but so they would also conform to the requirements of sound statistical design.

Being convinced that these designs are worth while is only part of the battle, and for engineers or chemists who have little or no training in formal statistics, it is only a very small part. To the uninitiated there are no simple rules to follow and modern theory of experimental design may well be discouragingly complex.

EDWIN C. HARRINGTON, JR., Manager of Industrial Statistics, Monsanto Chemical Co., Springfield, Mass.

Several years ago we faced exactly this problem, and from this experience there has evolved a pattern which seems particularly appropriate to the industrial type of experiment as it is undertaken in research, the pilot plant, and in the production areas.

The "master" plan is the complete factorial arrangement, including all of the processing or operational variables in which we are interested, each variable at as many levels as may seem worth while. From this "master" plan, then, is derived the final experimental design as dictated by the economics of the investigation; the availability of man power, equipment, and materials; the precision with which the data may be taken; and finally by the amount of information we are willing to sacrifice to economy.

The factorial, which will be described presently, is the ideal of the industrial statistician (*1*). It provides the most complete survey of processing variables; it is extremely efficient; and the interpretation of the data is straightforward, free from ambiguities, and thorough. Unfortunately, such perfection demands its price, and the factorial very rapidly grows beyond the point of practical application. It is here that the original complete factorial arrangement is of great value, because from it may be derived extensive modifications to reduce, as far as we wish, the size of the experiment to fit the limitations imposed by economy and practicability.

It is important to realize that at each stage in this reduction we lose some part of the inherent value of the full factorial—in general we lose some degree of precision and we lose in our ability to interpret the data without "strings attached." The final design is then a compromise, we hope optimum, between perfection and practicality.

This paper is intended to develop these ideas as they apply to a relatively simple problem in experimental design.

If we were to survey all of the experiments undertaken in the chemical industry of the United States at this moment, it would be safe to guess that the purpose of at least 99% of them would be to determine the effect of a single variable on some property or quantity effected by the change. Designs of this sort may be symbolized as in Fig. 1.

The processing variable whose effect is being studied is A, and the effect of changing A from A_1 to A_2 is simply the difference between the averages of the eight trials made at A_1 and of those made at A_2. To take a specific case, we might wish to determine the effect of temperature on the degree of conversion during a reaction. Two temperatures could be: A_1 = 120°C. and A_2 = 160°C. To determine the effect of this temperature change, we simply compare the average of the eight trials made at 120° with the average of the eight trials made at 160°. The difference between these averages is the effect we seek to measure.

This comparison is shown in a special sort of symbolism in the small plus and minus diagram at the bottom of the figure. This symbolism will be useful as we develop more complex designs.

This design follows the principles of classical experimentation—hold everything constant except the one variable you wish to evaluate. And there is nothing wrong about it except that by modern standards, it is extremely inefficient. In the old days people walked from Boston to New York one step at a time. Classical experimentation is also a step-at-a-time process.

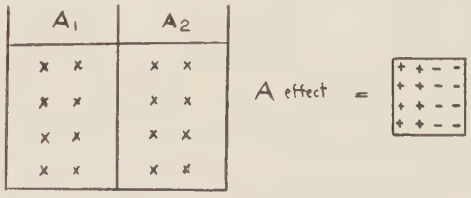


Fig. 1

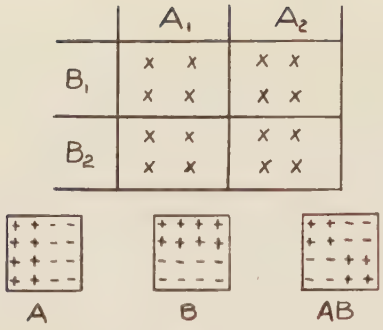


Fig. 2

The value received from the experiment may be markedly increased by introducing another variable into the design. In addition to temperature we may also evaluate, let us say, catalyst concentration, in the same 16 trials. This second variable, call it "B," is added to the design as shown in Fig. 2.

In interpreting the data from such an experiment, we first assume that the effect of A is completely independent of B: if going from A_1 to A_2 increases some measured property by 100 units when B is held constant at B_1, it increases that property by the same amount when B is held constant at B_2. The following is an example of that situation:

	A_1	A_2	
B_1	650	750	→ 100
B_2	800	900	→ 100
Av.	725	825	→ 100

Granting this assumption of independence, the effect of A is as before the difference between the average of all the readings at A_1 and all the readings of A_2. The plus and minus diagram for A symbolizes this comparison.

In the same way, the B effect is measured by the comparison taken as shown in the plus and minus diagram for B.

We have no certainty that the assumption of independence is valid. In fact, experience has shown that in chemical experimentation complete independence is a really rare phenomenon. This dependence of the effect of one variable on another is known in statistical terminology as interaction, and the interaction between variables A and B is directly measured by the plus and minus diagram for AB.

This peculiar pattern of plus and minus is easily derived if we agree that this dependence is measured by difference between the effect of A at B_1 and the effect of A at B_2. The mechanics of the derivation are as follows:

	A_1	A_2		
At B_1	+ +	− −	(effect of A at B_1)	(1)
	+ +	− −		
At B_2	+ +	− −	(effect of A at B_2)	(2)
	+ +	− −		

The difference between (1) and (2) is then

+	+	−	−
+	+	−	−
−	−	+	+
−	−	+	+

We shall use several more complicated plus and minus diagrams, and it is of some importance to understand the rationale of their peculiar structure.

It is also important to understand the physical significance of the term interaction. A commonly occurring example is the following:

		Catalyst X		
		0.1%	*0.5%*	
Reaction temp., °C.	120	75	85	(increase = 10)
	160	88	88	(increase = 0)

Where the figures (75, 85, etc.) represent the per cent conversion during a chemical reaction. Here an increase in the catalyst content was very effective in increasing conversions at 120°C., but was not effective at all when the reaction was carried out at 160°C. Catalyst X simply decomposed at the higher temperature before the reaction was stopped, and the 88% conversion was due primarily to the effect of temperature.

Every chemist will recognize this example as a familiar situation. He will also recognize that many of the controversial questions of science and industrial technology arise from failure to recognize the concept of interaction.

Referring again to the 2 factor experiment, Fig. 2, we see that by adding the second factor B, we have increased the "value received" from the experiment by 200% above that of the classical design. Instead of one effect A we can now evaluate A, B, and AB.

This is a practical world in which we never get anything for nothing. What then, has been the price of this extra information? In the classical experiment involving only A, we had 14 comparisons with which to estimate experimental error. (The statistician says we have 14 degrees of freedom for error.) When B is added to the experiment, there are left only 12 degrees of freedom for error, which roughly corresponds to a loss of precision of some 14%—not a bad price to pay for 200% increase in amount of information.

But statistical experimentation need not stop here. A third variable may be evaluated in the same 16 experiments by adding it to the design as in Fig. 3.

To interpret the data from such an experiment, we first make the assumption of complete independence between the effects of the three variables, at which time A and B are compared as previously and as shown in the plus and minus diagrams for A and B. The new comparison, for C, is quite obviously the C_1's versus the C_2's as in the diagram.

Two new interactions, AC and BC, take care of the situation where two of the variables are mutually dependent. And the three-factor interaction, ABC, completes the picture of all possible types of dependence.

We are familiar with the physical significance of two-factor interactions—let us see what a three-fractor interaction might look like:

		Catalyst X		*Catalyst Y*	
		0.1%	*0.5%*	*0.1%*	*0.5%*
Reaction temp., °C.	120	75	85	60	72
	160	88	88	83	94

The three factors are, of course,

Catalyst type	X, Y
Catalyst concentration, %	0.1 and 0.5
Reaction temp., °C	120 and 160

With catalyst X, there is obviously interaction between concentration and temperature as previously described. With catalyst Y, there is no such interaction. Therefore, the exist

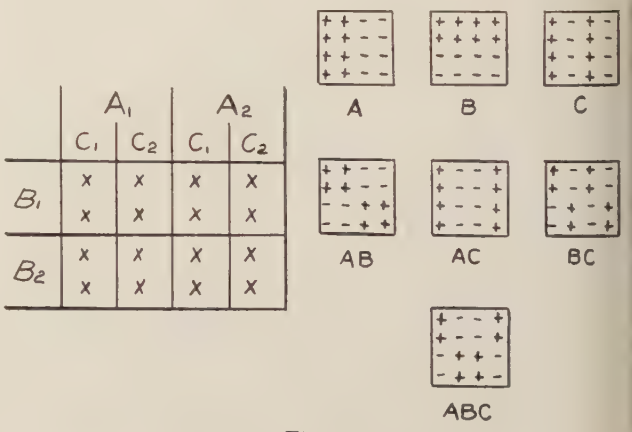


Fig. 3

		A_1		A_2	
		C_1	C_2	C_1	C_2
B_1	D_1	X	X	X	X
	D_2	X	X	X	X
B_2	D_1	X	X	X	X
	D_2	X	X	X	X

Fig. 4

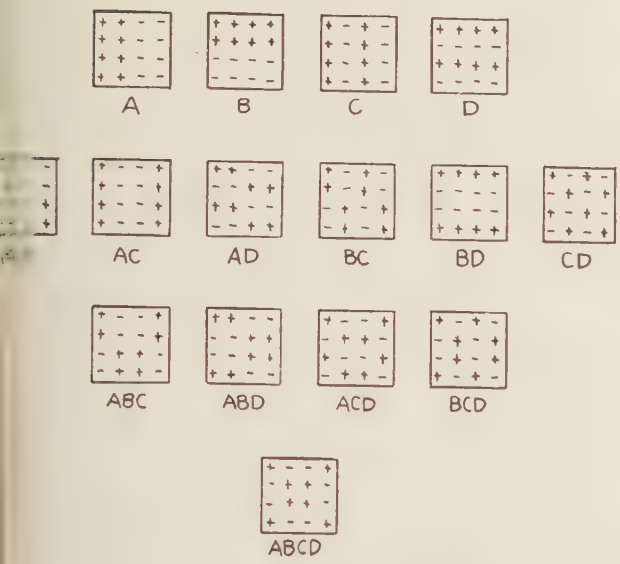


Fig. 5

...e of that interaction is dependent upon which type of ...lyst is used, and so we have a three-factor interaction.

...hose concepts, involved as they are, have had great ...tical application, for in this example, catalyst Y was con-...red unsatisfactory for the reaction. You will note that it ...ss reactive than X in three of the four combinations. ...act, it was accepted in industry as a rather inadequate ...lyst. Yet under certain conditions, evaluated in the ...rial and described in the significant three-factor inter-...on, the use of catalyst Y provided the most satisfactory ...ufacturing conditions.

...et us now compare the three-factor experiment involving ... variables A, B, and C with the single-factor classical ...riment involving only A. From the latter, we gain but ...bit of information: the effect of A when all other variables ...held constant at a specified level. From the former we ...e three main effects, A, B, and C, and for any one of them, ...e is no limiting requirement that the other variables must ...eld constant at a specified level. In effect we have moved ... a world of one dimension, to a world of three dimensions. ... in addition to these main effects, we may evaluate the ...ractions AB, AC, BC, and ABC. I hope you will agree ... these, if and when they exist, are quite as important as ...main effects.

...hat is the cost of this increase of knowledge? Neglecting ...e additional physical effort to incorporate three variables

		A_1		A_2	
		C_1	C_2	C_1	C_2
B_1	D_1	X			X
	D_2		X	X	
B_2	D_1		X	X	
	D_2	X			X

Fig. 6

Run only combinations marked X.

in one experiment, and neglecting the mental effort required to interpret the data (this does require some practice together with some acuity), the experiment has suffered somewhat less than 50% loss in precision: from 14 degrees of freedom for error, there are now only 8. In return, the experiment is capable of yielding seven times the amount of information that a classical experiment of the same size could yield.

For the purpose of describing experimental design, a fourth variable may be included in the original 16 experiments. The design is simply as shown in Fig. 4.

And the comparisons, of which there are 15 (compared with only one for the classical design), are shown in Fig. 5.

From 16 experimental runs there can be no more than 15 independent comparisons, all of which are now accounted for in evaluating process variables and their interactions. This leaves no comparison for experimental error, and therefore such a design cannot be subject to critical statistical analysis unless provision is made to evaluate error. There are several ways out of this situation, all of which require either additional testing (if we ran duplicates of all or of a part of the design we'd be in the clear again) or some sacrifice of information (by using the high order interactions as estimates of error). In either case it would not be sound reasoning to state that we had gained a 1400% in the utility of the experiment, although the gain is very large.

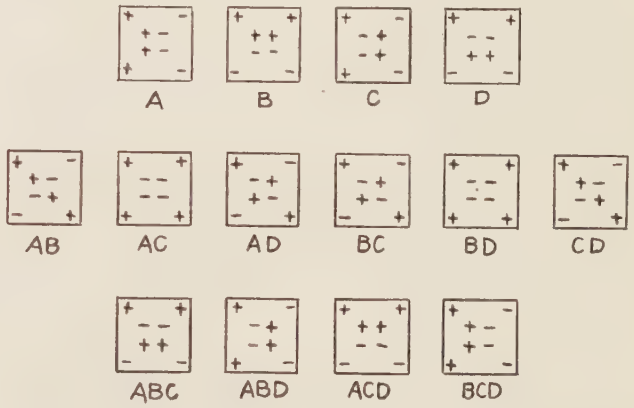


Fig. 7

Note identical comparisons (called "aliases"): A = BCD; B = ACD; C = ABD; D = ABC. AB = CD; AC = BD; AD = BC. These effects are "confounded".

As we increase the number of factors involved in any interaction, it becomes less and less likely that it truly exists. In a four-factor experiment, for example, if three of the four factors pertain to physical variables such as time, temperature, and concentration, and if the fourth is sociological such as technically trained versus operating personnel, it is unlikely that these four variables are mutually dependent. It is appropriate, then, to ask, is not the comparison for the four-factor interaction a waste of effort? How may we take advantage of this fact?

There are at least two commonly accepted procedures in current use. The first, "partial replication," is accomplished by omitting from the design either one of the two groups from which the ABCD comparison is made; i.e., omit either the plus group or the minus group from the pattern

$$\begin{array}{cccc} + & - & - & + \\ - & + & + & - \\ - & + & + & - \\ + & - & - & + \end{array} \quad \text{(ABCD)}$$

Such a design, illustrated in Fig. 6, reduces the size of the experiment to one-half that which was originally required in this case from 16 experimental runs to only 8. By partially replicating on the highest order interaction, we have arrived at the familiar Latin Square.

The comparisons by which we evaluate the main effects, A, B, C, and D, the two-factor interactions, AB, AC, AD, BC, BD, and CD, and the three-factor interactions, ABC, ABD, ACD, and BCD are diagrammed in Fig. 7.

All of these comparisons are perfectly valid, except it should be noted that now we have only four values to compare with four instead of eight with eight where we used the full factorial. This reduction of sensitivity is part of the price we pay for doing only half the work.

It is important to notice also that the comparison for A, for example, is identical with that for BCD. Any effect observed for A might also be due to BCD and from purely experimental evidence it is not possible to assign the observed effect to either A or BCD. In statistical terminology, these effects are inseparably confounded.

Further examination of the chart will show that every comparison is confounded with one other comparison; each has its "alias" as shown in the table. This could well invalidate the use of partial replication except there is a practical solution. If any one of the variables, A, B, C, or D, is chosen so that it is reasonably noninteracting, i.e., completely independent, it can be assumed all of the interactions containing that variable are nonexistent. This removes practically all of the confounding, and conclusions drawn from the data are free from ambiguity (*2, 5*).

The partially replicated factorial, or in this case, the Latin Square, is a valuable design in that it reduces the work of a complete factorial by at least one half (even smaller replicates are easily designed). In expensive experimentation, this could well save several thousands of dollars. However, it must be borne in mind that this is not a gift of the gods, but is paid for by a reduction of sensitivity and by the unavoidable confounding which has just been described.

There is a second trick which may be performed on the high order interaction of the complete factorial which may be useful. If, again, we may reasonably assume that this interaction is nonexistent, the comparison from which this interaction would have been estimated may be put to work by superposing a new variable on the erstwhile useless comparison. In this case, a fifth variable E is introduced into the design by assigning E_1 to the plus component of ABCD and E_2 to the minus component of ABCD. The variable E is thus confounded with ABCD, but since we assumed that ABCD was nonexistent, any significant difference observed in this comparison must be due to E. The design of such an experiment is shown in Fig. 8, and the interpretation of the independent comparisons which may be made from such a design is shown in Fig. 9.

It will be observed that by confounding E with ABCD, we have also confounded all of the other comparisons. Failure to realize this may lead to serious misinterpretation of the experimental data, but as with partial replication, proper selection of the variables may lead to very efficient experimentation. It is required that any one of the five variables be noninteracting. Again, as with partial replication, all confounding is removed except that which may exist between the noninteracting variable, taken alone, and its complimentary four-factor interaction.

There are many modifications of the designs we have discussed (*2*). As the number of variables increases, s greater efficiencies may be realized. The complete factori by using the same data in different combinations, represent tremendous increase in the value received as compared w the classical one-step-at-a-time procedure. Its recognit and evaluation of interaction provide far greater understa ing of the physical relations of the variables.

Factorial designs are not limited to two levels of e variable as we have discussed, but may be extended ind nitely. The situation becomes more difficult to explain beca plus and minus diagrams no longer apply, but all this has been worked out in detail in more advanced stud

Partial replications and confounding are but two of modifications which may be performed on the comp factorial. Situations arise where deficiencies in raw mate supply or availability of equipment do not allow the inher symmetry of the factorial or its partial replicate. The complete" designs, requiring somewhat more adva techniques in interpretation, (*1, 2*) are again quite e derived from the factorial.

Finally, the relatively new designs in which the object discover optimum conditions for the manufacture of m rials (contrasted with the foregoing where the object has b to evaluate the effect of process variables) are again modif tions of the complete factorial where predetermined patt are progressively selected to close in on, and eventually point, the optimum control of process variables. Insofa these patterns follow the factorial, they, too, benefit by inherent efficiency and exhaustive analysis of interdepende

We have ventured rather far into experimental design hope that in addition to again demonstrating the valu designing experiments so that they conform to the requ ments of sound statistical design, I have also established way of the factorial, a starting point for greater efficienc industrial experimentation, and for more thorough anal of experimental data. One final point, if the interpreta of these designs appears to be complex, it is so not bec statistics makes it so, but because nature itself is com Don't blame the statistician—he is only providing the t niques to handle those situations which already exist.

		A_1		A_2	
		C_1	C_2	C_1	C_2
B_1	D_1	E_1	E_2	E_2	E_1
	D_2	E_2	E_1	E_1	E_2
B_2	D_1	E_2	E_1	E_1	E_2
	D_2	E_1	E_2	E_2	E_1

Fig. 8

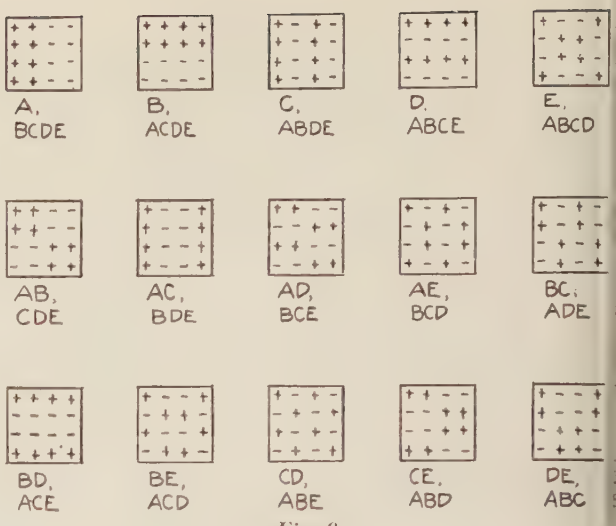


Fig. 9

LITERATURE CITED

1. Brownlee, K. A., "Industrial Experimentation," Chem Publishing Co.
2. Cochran and Cox, "Experimental Designs," John Wiley
3. Bicking, C. A., "Industrial Quality Control," Vol. No. 4. Statistical Methods in Chemical Development.
4. Adams, C. H., "Industrial Quality Control," Vol. VII, 4. Application of Statistical Techniques to the Phy Testing of Plastics.
5. Davies, O. L., and Hay, W. A., "Biometrics," Vol. VI, N The Construction and Uses of Fractional Factorial De in Industrial Research.

icago

e Chicago Section met at the Chicago Bar Association oom in Chicago, Ill., on March 16, 1953. C. H. Krebs las Boxmakers, Inc., and vice-chairman of the Section led. Frank W. Egan, President of Frank W. Egan & Bound Brook, N. J., was the principal speaker. His t was "Laminators." His remarks follow:

Laminators

Frank W. Egan

IT HAS been said that laminating is a simple operation. at is necessary is to apply an adhesive to the face of eb and bring it into contact with the face of another nd the operation has been completed. It sounds , but there is a great deal more to consider before accept- minating is accomplished.

the past 30 years I have been designing and building tors. Experience has taught me that the major fac- proper laminating are: (1) web tension, (2) moisture ion, and (3) bonding.

WEB TENSION

old method of applying tension on the web, by using n brakes on the unroll shaft will not do. Why? Simply se the web varies in caliper from one side to the other ng in a hard and soft roll, from one edge to the other, cing angular draw wrinkles.

ther, if a roll, let's say is 30 in. in diameter and on a 3-in. eter core, we have a 10 to 1 change in tension on the v.

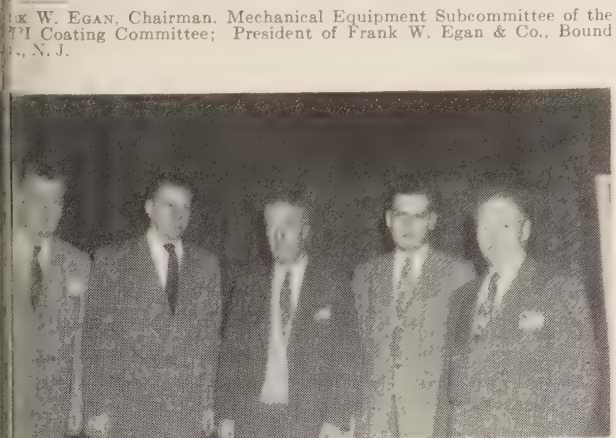
he proper method to use is to drive the unroll shaft with a or that acts as a drag generator and control the speed of motor through a float roll, using only sufficient tension eep the roll of paper or paperboard from unraveling. n apply the correct amount of tension to the web, by ing it around two tensioning rolls that are driven slightly er than the laminating rolls. The tensioning rolls should rranged in an S formation and positioned as close as ible to the adhesive applying unit. In doing so, the ten- ing rolls will act as leveling rolls and only apply tension he web in the short draw between the tensioning rolls and laminating rolls.

s on the unroll shaft drive, the tensioning roll drive acts drag generator drive.

is good practice to use a roll guide to automatically e the web to the adhesive applicator, if the draw from unroll stand is long, or if the rolls are unevenly wound.

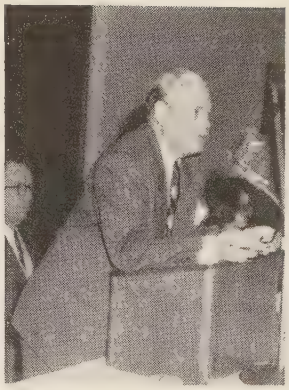
he control of the tension on the web is very important, varying tension upsets the bond in the same degree as

K W. EGAN, Chairman, Mechanical Equipment Subcommittee of the PPI Coating Committee; President of Frank W. Egan & Co., Bound ., N. J.



McIntire, H. B. Fuller Co.; C. H. Krebs, Atlas Box- ers, Inc.; F. W. Egan, Frank W. Egan & Co.; J. D. son, Container Corp. of America; and E. C. Berg, Ace Carton Co.

C. H. Krebs, Atlas Box- makers, Inc.



E. C. Berg, Ace Carton Co.

the tension varies. Varying tension on the web produces mechanical curl in the laminated web.

MOISTURE RETENTION

The main feature in the application of the adhesive to the web is the moisture retention. There is no need of applying an adhesive high in moisture content thereby making it necessary to dry out the moisture before cutting or winding the laminated web. For, if it is necessary to pass the laminated web around drying drums, the operation delaminates the web and it also destroys its rigidity. Excess moisture retention produces a wet curl in the laminated web.

Naturally, the best method to use is to apply the adhesive to both webs and then bond them together, for in doing so, you have a balanced condition providing both webs of paper or paperboard are similar in furnish and caliper. But, with the high speeds at which laminators are operated today, the application of the adhesive to one web seems to produce a satisfactory product.

The adhesive applicator that applies the most uniform film of adhesive to the web regardless of its width and with a high solids content in the adhesive, consists of two chilled iron rolls ground with a concentricity of 0.0002 in. and bored for heat. They are arranged horizontally and positioned in a pan of adhesive placed in a heated jacketed outer pan. Both rolls rotate in the same direction, as the travel of the web of paper or paperboard. One roll acts as the applying roll, applying the adhesive to the surface of the web of paper or paperboard. The second roll acts as a metering roll, shearing off the excess adhesive and in doing so, permits the use of straight face rolls, the application of adhesives containing a high solids content, besides reducing pressure at the nip. The metering roll should be provided with a cleaning doctor and it should be rotated slightly faster than the applying roll, so as to prevent any paper fibers picked up by the applying roll from sticking in the nip, thereby producing streaks in the applied adhesive.

To complete the adhesive applicator, there should be a bow bar, or curved roll, bearing on the back of the web, just before it touches the applying roll, for the wetting of the web causes it to expand and causes wrinkling. When the machine is shut down, provisions must be made to rotate the adhesive rolls, keeping them in an ever ready applying condition and doing away with any need of cleaning the rolls, which accounts for a great deal of down time. A third provision, is a means of lifting the web from the face of the applying roll during the shutdown period.

BONDING

The method of bonding, or laminating, is determined by the nature of the web. If the web is open, or porous to the degree that the adhesive passes through the web readily, then the laminating rolls should be operated in an open manner, or an S formation, so as to prevent a strike-through of the adhesive on the outer surface of the laminated web.

If curl is no problem, then a metal roll and a rubber-covered roll, not driven, can be used to apply pressure-type lamination.

The best method of lamination or bonding is to use two chilled iron rolls, large enough in diameter to prevent deflection, utilizing the weight of the upper roll and using the pressure method to calender the two or more webs as they are laminated simultaneously.

All of the adhesive applicators are to be equidistant from the nip of the laminating rolls.

Each web is to lay on the face of either the top or bottom laminating roll, before it enters the nip.

The top and bottom laminating rolls are to be driven independently so as to prevent any curl in the laminated web for the caliper of the web or webs laying on the face of the laminating roll must be added to the radius of the roll to determine the speed of the web, or combined webs, which in turn determines the combined tension and has a decided bearing on the curl in the finished laminated web.

Light caliper laminated webs can be wound into rolls.

Heavy caliper laminated webs should be carried straight to the cutter, thereby overcoming any delamination of the web and maintaining its laminated rigidity.

In using adhesives having 60 to 65% solids, only 1% or less moisture is retained in the finished laminated stock.

In handling heavy caliper webs, idler rolls having large diameters should be used between the unroll stands and the laminator, to prevent checking.

This article referred to what I consider the best type of laminator for general use. For other types of laminators you can refer to the recently published fifth edition, third volume revised textbook "'The Manufacture of Pulp and Paper" prepared under the direction of the Joint Textbook Committee of the Paper Industry of the United States and Canada.

W. R. Price, *Recorder*

Southeastern

The Southeastern Section met on March 20 and 21 in Macon, Ga., at the Dempsey Hotel. Attendance was excellent with 140 members and visitors registering.

The evening program consisted of a dinner, followed by a motion picture on defoaming agents and two technical papers. The first of these, "Bleaching with Chlorine Dioxide," was presented by Ward D. Harrison, Vice-President in Charge of Production, Riegel Paper Corp., Milford, N. J. The second paper covered "Neutral Sulphite Semichemical Spent Liquor Recovery," and was presented by G. H. Chidester, Chief, Pulp and Paper Division, U. S. Forest Products Laboratory, Madison, Wis. Abstracts of the two papers are given below.

The program for the second day of the Macon meeting consisted of a tour of the plants of the Macon Kraft Co. and of the Armstrong Cork Co.

Bleaching with Chlorine Dioxide

Ward D. Harrison

The bleaching and purification of chemical wood pulp has almost always been carried out with chlorine or chlorine containing compounds. Many other materials have been tried but most of them have been discarded as being impractical. The one notable exception is peroxide. Elemental chlorine and either calcium or sodium hypochlorite have been the most important chemicals used because of their economy and ability to purify and bleach. Purification (lignin and other encrusting material removal) is easily affected to a large degree by chlorination and later extraction under suitable conditions of temperature, pH, etc., without excessive

G. C. Kimble, Union Bag & Paper Corp. and Chairman of the Southeastern Section of TAPPI, welcomes members and visitors to the meeting of the Section at Macon, Ga. on March 20. Seated left to right are: M. B. Pineo, Brunswick Pulp & Paper Co.; Herbert A. Kidd, Macon Kraft Co. G. H. Chidester, U. S. Forest Products Laboratory; and Ward D. Harrison, Riegel Paper Corp.

damage to the pulp. Bleaching of the coloring matter and destroying final traces of lignin, however, have been most difficult to accomplish without damage to the cellulose (and particularly for kraft pulps). Oxidizing agents capable of completely destroying the coloring matter such as the hypochlorites are almost universally used even though they seriously degrade the cellulose when used in amounts large enough to insure high color.

This situation has urged the pulp chemist, engineer, and operator on in the quest for and practical use of oxidizing agents which would bleach but not attack the cellulose. In the last few years, chlorine containing materials such as chlorous acid and chlorine dioxide have aroused great interest because of their unusual property of bleaching cellulose without degrading it.

It is not necessary to go into the history of the discovery of these compounds and their application to pulp at this time because of the excellent coverage of this subject by Cascioni and Hatch. Cascioni published in the March 6, 1953 *Paper Trade Journal* an excellent article on chlorine dioxide. It is particularly valuable from an historical and bibliographical standpoint. One hundred and eight references to the literature are made. Hatch in one chapter of the book "The Bleaching of Pulp," to be released shortly by the Pulp Publication Committee of TAPPI also discusses this subject.

The active oxygen equivalent (oxidizing power) of some chlorine compounds are as follows:

Chlorine	Cl_2	C
Hypochlorous acid	HOCl	C
Sodium hypochlorite	NaOCl	C
Sodium chlorite	$NaClO_2$	C
Chlorine dioxide	ClO_2	C

Since chlorine dioxide and the chlorites are in a higher state of oxidation than the hypochlorites, it might be expected that chlorine dioxide and the chlorites would have a greater degrading effect on cellulose. This, of course, doesn't happen because the hypochlorites are more powerful oxidizing agents and exert a higher oxidation potential. Furthermore, it is a well-known fact that both chlorine and hypochlorite will readily oxidize arsenious acid while chlorine dioxide, chlorous acid, and the chlorites will not. Even so, and regardless of whether oxidation potential, state of oxidation, or availability of chlorine in chlorine dioxide is the most important, it is fortunate that its terrific capacity to bleach is just strong enough to do the job without degrading the cellulose.

Ward D. Harrison, Vice-President in Charge of Production, Riegel Paper Corp., Milford, N. J.

. Chidester, Chief, Division of Pulp and Paper, U. S. st Products Laboratory, outlines methods of recover- neutral sulphite semichemical spent liquors, as a ure of the meeting of the Southeastern Section of TAPPI at Macon, Ga., on March 20

ere are six methods of preparing chlorine dioxide:

Laboratory method—Reaction of chlorate with oxalic acid.
Holst process—Reduction of chloric acid with sulphur dioxide.
Persson process—Reduction of chloric acid with chromium sulphate and regeneration of the chromium sulphate with sulphur dioxide.
I.G. Farben. process—Similar to Holst except chlorine dioxide is first formed into zinc chlorite.
Brown process—An electrolytic method.
Solvay process—Reduction of chloric acid with methanol.

rom the time the Riegel-Carolina mill was conceived, its cification included the condition that it be capable of pro- ing bleached pulp of: (1) high strength, (2) high color, and low dirt count.

n considering the bleaching process to help attain this cification, it was obvious from the very start that chlorine xide bleaching would be a great help in accomplishing the l. Results indicate the objectives have been attained.

The bleaching process at Riegel contains six continuous rtion stages each of which is followed by a wash as follows: low density, chlorination; (2) high density, first caustic; high density, first hypochlorite; (4) high density, second stic; (5) high density, second hypochlorite; and (6) high sity, chlorine dioxide. The first five states are conven- aal and will not be considered here.

BLEACHING EQUIPMENT

The stock leaving the fifth stage washer is maintained between 13 and 15% moisture-free consistency. From here it falls through a pipe directly into a high density stock pump which delivers the pulp to the mixer under pressure. Steam is applied just as the stock enters the mixer and water containing chlorine dioxide is added to the mixer near the stock entrance. The pulp, well mixed with the bleaching chemical and steam, is continuously delivered to the top of the chlorine dioxide tower. The pulp works its way down through the tower in the normal manner and finally enters the dilution zone. Here it is mixed with caustic to neutralize the acid and residual chlorine dioxide. The diluted and neutralized stock is withdrawn from the bottom of the tower continuously and pumped to the sixth stage washer.

Since it seems desirable to improve the method of heating the pulp, it has been suggested that a mixer (steam and pulp) be installed directly below the washer preceding the chlorine dioxide stage. At Riegel-Carolina the consistency of the pulp in the tower is limited by the consistency which can be made to enter the thick stock pump. It has been suggested that thicker stocks could be pumped if the pulp was urged into the pump with the help of a feeder. A flutter-type feeder has been proposed and, no doubt, this will be installed on the next installation.

BLEACHING DATA

Generally speaking, the pulp entering the sixth stage has not been degraded (strengthwise) as compared to the unbleached pulp and is in the G.E. brightness range of 60 to 70.

The data in Table I show typical results obtained when bleaching both pine and hardwood sulphate under various conditions. These data were not developed on a research basis but taken from the log sheets of actual mill operation. The data were developed from tests on composite samples over a period of time. Consequently, a number of uncontrolled variables such as wood quality, etc., have influenced the results to some degree. Samples 1 and 8 in the table were taken off the screen room decker ahead of the bleach plant. All other samples were taken at the discharge of the pulp drier following the bleaching operation. Sample 2 illustrates in general the characteristics of the bleached pulp preceding the chlorine dioxide stage.

Sample 7 is included to show the effect of temperature. In this case, the temperature controller regulating the chlorine dioxide stage became inoperative and probably allowed the temperature to rise as high as 200°F. Pulp degradation appears to increase as the temperature rises above 160°F. These data are not complete enough to make any observations

Table I. Pulp Characteristics Developed Under Varying Bleaching Conditions

	1	2	3	4	5	6	7	8	9	10
od	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Hard	Hard	Hard
er Conditions										
ClO_2, %	Unbl.	0	0.293	0.505	0.525	0.643	0.434	Unbl.	0.415	0.560
onsistency (moisture-free), %	...	..	11.5	11.0	11.6	12.2	13.0	...	10.5	12.0
ime, hr.	...	..	1.9	2.3	2.1	2.6	2.8	...	2.4	3.0
emperature, °F.	...	..	150	155	155	165	170+	...	155	155
Characteristics										
irt, p.p.m.	...	7	5	3	3	2	2	...	3	3
rightness, G.E.	25.0	67.8	79.4	81.9	84.5	88.4	88.6	25.0	82.3	85.1
500 ml. freeness										
Beating time, min.	25	33	26	30	32	25	25	8	15	21
Burst	54	57	62	58	58	53	33	...	30	31
Tear	93	75	84	86	82	79	65	...	69	78
Fold, M.I.T.	860	900	860	980	1000	660	310	...	75	50
300 ml. freeness										
Beating time, min.	39	52	43	48	49	39	41	20	35	42
Burst	68	62	68	63	63	59	38	42	44	43
Tear	77	70	82	80	76	69	55	69	62	67
Fold, M.I.T.	1080	1350	1400	1625	1250	1025	650	450	540	385

l tests were made according to TAPPI Standards as follows: beater testing, T 200 m-45; freeness, T 227 m-50; sheetmaking, T 205 m-47; Burst and T 220 m-46; fold, T 423 m-50; brightness (handsheet), T 218 m-48; brightness, T 217 m-48; dirt, T 213 m-43.

concerning consistency and retention time but the limits shown are practical for the equipment in question. Higher consistencies would give higher retention times, and no doubt, in the future, equipment will be designed to go in that direction. It should be pointed out here that there is still much to be learned in how to pump and mix stock above 12% consistency for chlorine dioxide bleaching.

CHLORINE DIOXIDE MANUFACTURE

The plant consists essentially of three reaction towers for the evolution of gaseous chlorine dioxide, two absorption towers for the absorption of the gas in water, two product receiving tanks for storage of chlorine dioxide solution, and a spent liquor neutralizing tank for the neutralization of sodium bisulphate with soda ash.

The ceramic reaction towers are packed with Raschig rings. Sodium chlorate–sulphuric acid liquor is pumped from the bottom of each tower through heat exchangers and into the top of the tower.

Acid and chlorate liquor is passed through the reactors in series. This liquor enters just ahead of the circulation pump of the first reactor and constantly flows from the bottom section of each tower into the pump suction of the next. Liquor from the third tower flows by gravity into the spent liquor neutralization tank.

Methanol is added to the nos. 1, 2, and 3 reaction towers just ahead of the circulation pump. It starts the reaction and keeps it going in each tower. Hot air is forced by a blower into each reaction tower just below the tower packing and as it passes upward it strips the chlorine dioxide from the downward flowing chlorate-acid liquor. Approximately 70% of the chlorate is reduced in the first tower, 20% in the second, and 10% in the third.

Chlorine dioxide gas is blown from the top of the reaction towers into the bottom of the absorption tower. These towers are stoneware and packed with Raschig rings. The gas is absorbed in a downward flowing stream of water which flows by gravity into the chlorine dioxide receiving tank. Absorption water of not over 50°F. temperature is supplied by a steam jet refrigeration unit.

The steam used by the refrigeration unit is condensed with water in a barometric-type jet condenser. The condensate and condensing water mixture flows by gravity into a concrete hot well. From here it is pumped to an evaporative cooling tower, cooled, and returned to the condenser as condensing water.

DANGERS IN CHLORINE DIOXIDE MANUFACTURE

Much has been said in regard to the dangers encountered in the manufacture and use of chlorine dioxide. It is a gas at room temperature and similar to chlorine. It is unstable and has a disagreeable odor. Chlorine dioxide is toxic and irritating to the eyes, nose, and throat and care must be used in protecting all those who work around it. Outdoor construction of chlorine dioxide plants is desirable to prevent high concentrations of the gas being around the equipment. Gas mask protection should be provided for emergency situations.

The handling and use of sulphuric acid is well known and the usual precautions should be observed. The acid or reactor solution should not come in contact with the skin or clothing. Containers of sodium bicarbonate solution should be available for neutralization of any acid solutions spilled on the operators.

Sodium chlorate solution is harmless, but after drying on organic substances, such as clothing, gloves, and wood, the chlorate is inflammable and dangerous. Any spillages of chlorate should be washed away immediately with large quantities of water.

Methyl alcohol is an inflammable chemical and the usual precautions in its handling should be carefully observed. Its vapors are poisonous and should not be inhaled by the operators.

Concentrated chlorine dioxide gas is explosive and must be diluted with air. The mixtures should not contain more than 10% chlorine dioxide by volume. Consequently, the control of air to the reactors is most important and failure of the air blower for any reason is most serious. All possible safeguards have been installed to combat this condition.

In summing up the dangers of chlorine dioxide manufacture it has been found to be no more dangerous than the manufacture and use of other toxic and acid chemicals. Standard practices are well defined. If reasonable precautions and safeguards are exercised, no trouble should be encountered.

MATERIALS RESISTANT TO CHLORINE DIOXIDE

Chlorine dioxide in water solution and the reaction solution (sodium chlorate, sulphuric acid, and methanol) must be handled in tanks, towers, piping, and pumps in the manufacture and use of chlorine dioxide. Because both of these solutions are extremely corrosive, materials of construction become very important. The following materials have been found satisfactory for use as designated:

1. Saran pipe—Satisfactory for reactor or chlorine dioxide solution.
2. Kel-F—Satisfactory for valve diaphragms for reactor and chlorine dioxide.
3. Durichlor—Excellent for both solutions—pumps.
4. Karbate—used for heat exchanger tubes and thermometer wells in reactor solution—satisfactory where pressure in line is low—one year limited life is expected.
5. Stainless Steel 316,304—Not satisfactory.
6. Chemical stoneware—Satisfactory if protected from thermal shock.
7. Porcelain—Satisfactory.
8. Alkor cement—Satisfactory if no movement of joint takes place. Unsatisfactory where the joint can be eroded such as in a mixer.
9. Vitroplast—Excellent even in a mixer.
10. Saran rubber—Used for gaskets—not resistant. Becomes resistant when coated with Sarancote.
11. Tygon—Used for gaskets—better than saran rubber but not perfectly resistant—becomes hard.
12. Teflon—Satisfactory—has been used for head gaskets on reactor pumps, pump packing, pipe gaskets.
13. Hastelloy C—Not satisfactory for reactor solution—probably satisfactory for chlorine dioxide solution—used in mixer.
14. Ircamet—Probably not satisfactory for reactor solution—satisfactory for chlorine dioxide solution—pumps.
15. Chemical brick—Satisfactory.
16. Sodium silicate cement—Satisfactory in top of chlorine dioxide tower as long as conditions are on the acid side.
17. Glass—Satisfactory.
18. Sarancote—Generally satisfactory but is showing some deterioration on one tank cover.
19. Atlastavon 30—Probably satisfactory in light of existing data. Laboratory data—excellent.

CONCLUSION

The manufacture and use of chlorine dioxide in bleaching wood pulp made from southern woods have been discussed in detail. The results indicate that pulp can be bleached in a single stage from the 70 to 60 G.E. brightness range to the 80 to 90 G.E. brightness range with less than 1% chlorine dioxide and with very little if any, loss in strength. The cleanliness of chlorine dioxide bleached pulp is remarkable.

Toxicity and explosion hazards have been pointed out. Material of construction difficulties are being slowly overcome.

Even though this report shows that good progress has been made in the manufacture of chlorine dioxide bleached pulp it would be very bad, indeed, not to point out that much work has yet to be done in order to improve the process as described here. The reaction for producing chlorine dioxide must be studied to make it more efficient, new materials of construction must be tried in order to find ones that are more corrosionproof, and a method of applying chlorine dioxide to pulp at considerably higher consistencies are but a few of the more pressing problems confronting the pulpmaker wishing to use this method of bleaching. Certainly, further developments will be made because many will be thinking about and working

chlorine dioxide bleaching. The papermaker is going to and more pulp bleached in this manner for his best des in the future.

Neutral Sulphite Semichemical Spent Liquor Recovery

G. H. CHIDESTER of the Forest Products Laboratory ented a brief résumé of the present status of various proc- for recovering neutral sulphite semichemical cooking uor. He pointed out that interest in such recovery is unting rapidly due to the increased use of semichemical ing. Currently, most neutral sulphite spent liquors are dled with sulphate liquors and recovered for use in the hate processes by conventional methods.

Basically, recovery of neutral sulphite spent liquors for e as sulphite liquor may be accomplished in one of four : (1) carbonation, (2) oxidation, (3) crystallization, or n exchange.

Of the four methods, only the first is known to be in com- ial use, in Sweden, where it is economically competitive sulphate kraft recovery, once the rather costly plant is . In this process the liquor is evaporated and burned the conventional manner, and the smelt is dissolved. tment with carbon dioxide yields sodium carbonate with hydrogen sulphide evolved being burned to sulphur de in a pyrites burner. Further carbon dioxide treatment s sodium bicarbonate which is then reacted with the ur dioxide to form sodium sulphite and carbon dioxide. latter may or may not be used in one of the earlier stages.

of the oxidation processes, Mr. Chidester mentioned one in h the smelt is dried, then brought into contact with air der controlled conditions at 300° F., which oxidizes the fium sulphide to sodium sulphite and sodium sulphate. he "Sulfox" process falls into this category.

The crystallization method of recovery makes use of the t that sodium sulphide is far less soluble in green liquor an is sodium carbonate, and may therefore be crystallized d recovered from green liquor.

In an ion-exchange process not yet on a commercial scale, solved smelt is forced up through a resin bed exchanging drogen ions for sodium ions with the formation of hydrogen phide. Regeneration of the resin beds results in the for- tion of sodium bisulphite. A recovery of 95% of the soda d 42% of the sulphor is claimed.

In another process, Mr. Chidester stated that spent neutral phite liquor was heated to 500°F. under a pressure of 800 s.i., yielding sodium sulphate and sodium acetate. There some build-up of acetate in the system, but complete noval of the biochemical oxygen demand of the spent liquor claimed. The process is interesting for the reason that no aporation or burning is required. Mr. Chidester knew of way to convert the sulphate back to sulphite.

All of these require a comparatively high capital invest- nt, and all but the first still need pilot plant development.

JAMES E. OVERALL, *Corresponding Secretary*

elaware Valley

The March meeting of the Delaware Valley Section was ld at the Engineers Club in Philadelphia on the evening of rch 26. One hundred and twenty-three members and ests attended the supper and evening meeting.

Harold Brill, Section Chairman, opened the meeting by roducing R. G. Macdonald, Secretary-Treasurer of Na- nal TAPPI. Mr. Macdonald spoke briefly, congratulating e Section on its well-attended meetings and on its monthly s letter edited by Jack Harper.

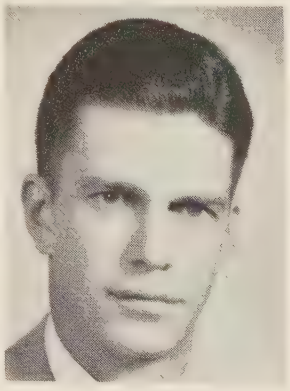
Then Mr. Brill introduced John Weidner, Chairman of the minating Committee, who announced the slate of officers the 1953–54 term. After this Frank Lovegren, program airman, gave a brief report on the February meeting in w York of the officers of the local TAPPI Sections.

After the business meeting Philip Nethercut introduced John R. Curtis, Chief Staff Development Engineer, Scott Paper Co., who spoke on the subject "Increased Production from Existing Machines."

Increased Production from Existing Machines

John R. Curtis

NO MATTER whether you operate a paper mill, a pulp mill, a converting plant, or a hot-dog stand, the key to reduced unit operating costs and increased profits is greater productivity. The plant utilizing only a small portion of its productive capacity usually does not remain in business very long due to its high overhead. By the same token, the mill which runs at full capacity, pushing equipment to its efficient limit, yields more sales dollars for every dollar invested. This means greater profits. All of this is very fundamental, and yet in the face of certain operating bottlenecks, many of us fail to strive for increased production. We find it easier to sit by, blaming our low output on mechanical limitations, than it is to act to eliminate our problems.



John R. Curtis, Scott Paper Co.

I do not profess to be an efficiency or a production expert; but I, like you, have been faced with production problems for many years. For the next few minutes let each of us imagine himself to be a consultant who has been called into a mill to analyze production and to recommend a sound program for increasing plant output. This mill could be your own. Where and how would you start?

NEW MACHINE OR OLD, REVISED?

There are two basic methods of increasing production. The easy and sure way is to install additional equipment. However, an additional machine requires more space, greater capital investment, additional personnel and supervision, more equipment and auxiliaries, etc.

The second method is more difficult, but the net return, per dollar invested, is usually much greater. In 95% of the mills you, as a consultant, would be asked how to increase the output of existing equipment. This is the daily problem which faces you as mill superintendents.

The truly progressive mill adheres to neither approach exclusively, but rather exploits both methods to advantage. The battle to increase output from existing equipment should be a continuing one, whereas complete new machines should be installed only after careful consideration of market and credit conditions. We have exploited our existing paper machines to the fullest by eliminating one bottleneck after another. Today the same basic machine on which I third-handed in 1935 has more than doubled its speed and even higher production rates are contemplated. This improvement has not been the result of one or two major rebuilds, but rather, has been achieved by continuing revisions each year. Each change has been justified by promising a pay-off in higher production or reduced costs within a 2-yr. period.

Most processes in the industry, whether papermaking, pulp making, or converting are subject to this same treatment. Continuing development of this nature is relatively simple to engineer and easy to finance since one or two problems are attacked at a time and the pay-off period is short. Each step, small as it may be, can be made to fit into your over-all

JOHN R. CURTIS, Chief Staff Development Engineer, Scott Paper Co., Chester, Pa.

program. In most cases, the chief difficulty is one of maintaining continuity in the program. When one bottleneck has been overcome, most of us are usually satisfied to sit back and relax forgetting the many problems yet unsolved.

THE ELIMINATION OF A BOTTLENECK

There are three general steps in the practical attack on any production bottleneck: (1) definition of the problem, (2) engineering and application, and (3) follow-up.

It is unfortunate that most of us practically ignore steps one and three, feeling that engineering and application alone will solve the problem. In many cases it is difficult to define or state the problem correctly so we by-pass it and launch ourselves directly into engineering a solution. We, as consultants, would have to define our problem accurately before making any recommendations.

It is true that much paper mill engineering is done on the basis of "hunches" and "impressions." Many such moves are successful, however, best and most consistent gains result from a sound, factual approach. Once we can state the problem clearly and positively, it usually is a simple matter to engineer the solution.

We would probably start our investigation by selecting half a dozen people and asking them the five all-inclusive questions—"how," "what," "when," "where," and "why." We would probably get six different anwers to each question. This is natural for each man has made observations which have created impressions; these impressions to him are facts. Analysis of these so-called facts shows a number to be contradictory, and others to be of questionable soundness. Here we must attempt to retrace the individual's line of reasoning and then possibly we may arrive at one or two fairly sound facts from a number of different observations.

For example, an operator having difficulty maintaining clean felts might feel that a different felt design was required when actually some white water was getting into his felt showers. Or he might condemn the boiler house superintendent for low steam pressure and poor drying when actually his driers were partially filled with water.

Several years ago we followed the "impressions" of our operators in the handling of a problem in a machine press section. The machine in question had only two thirds the vacuum pump capacity available to other machines and, since a machine tender never has enough vacuum, it was generally felt that this was the bottleneck. We installed a pump giving this machine one third more vacuum capacity than any other machine and were greatly disappointed to find the increase in dryness so small as to defy measurement. We had simply not defined our problem properly. (This should not in any way be taken as an indication that increased vacuum pump capacity might not be the solution to some other press section problem.)

The definition of a problem requires at least a sound analysis of existing records and observations, and more frequently calls for several well-selected tests or experiments. In our case, we could have piped a pump from an adjoining machine to the questionable press section. Then a few simple moisture tests would have told us that greater pump capacity was not the answer.

The third factor, follow-up, is equally important. Maximum gains will never be derived unless the "kinks" are ironed out of a new installation and the operators are thoroughly trained, not only in the use of the equipment, but also as to why it is an improvement, and what is being corrected. The men who operate a new process must understand it and believe in it, or it will never work properly.

THE MACHINE PRODUCTION PROBLEM

As consultants on a paper mill production problem, we could start our assignment by listing a number of general influences on machine production. These, we would find, fall into three classifications:

A. Speed
   1. Operating bottlenecks which limit top machine speed
   2. Equipment limitations which prevent continuou operation at top speed.

B. Lost Time
   1. Machine snaps and breaks.
   2. Clothing changes (wires, felts, rolls, etc.).
   3. Routine maintenance.
   4. Engineering changes.
   5. Accidents.

C. Waste
   1. Excessive waste on turnovers.
   2. Damage in handling rolls and finished product.
   3. Rejections for poor quality.
   4. Excessive waste in converting.
   5. Inability to use full machine trim.

These influences may be summarized in chart form fo any machine being analyzed. Suppose the following condi tions prevailed at the mill in question:

Basis weight (24 × 36—480), lb.	2
Dryness at reel, %	9
Trim, in.	12
Average reel speed for month (30 days), f.p.m.	100
Maximum reel speed in past, f.p.m.	120
Lost time during month for breaks, etc., hr.	2
Lost time during month for clothing, hr.	1
Lost time during month for accidents, hr.	
Lost time during month for engineering changes, hr.	
Waste and unaccountable losses, tons	4

This particular machine produces 400 lb. of moisture-fre paper per hour per 100 f.p.m. of speed. Thus, in terms of pr duction, we can prepare the chart in Fig. 1.

The collection of data on waste and lost time may requir special studies and records since all mills do not compile suc statistics. An analysis of these data in chart form woul quickly indicate the machine potential and points of majo inefficiency. Our recommendations would be directed a the elimination of such "bottlenecks." In our final report t management, we would outline several programs, each cos ing a given number of dollars, and each increasing the machin potential by a certain tonnage. These points would, course, be added to the chart later when corrective measur had been formulated. The final recommendations for t solution of each problem in our program would involve so combination of the following: (1) correct use of existi equipment, (2) engineering changes to permit improved p formance, and (3) training program to familiarize operato with proper techniques and to secure their active coope tion.

So far we have been very general in outlining an approac to a production problem. You all realize that in a discussio of this nature it is impossible to become so specific as to answ each of your production problems. If I possessed that hap faculty, I would certainly hang out a shingle as a "productio expert." However, in order to focus your attention on th more practical aspects of the problem, perhaps a few specif examples should be cited. Due to the limited time availabl these will be confined to papermaking, although simil programs could be developed for pulp making and for finis ing operations. Let us consider briefly the three gener factors affecting production: (1) speed, (2) lost time, and (waste.

THE SPEED PROBLEM

On all machines the gradual increase in speed will eve tually make the headbox level a limiting factor. In so cases you will find a considerable head loss from the scre discharge into the headbox limiting the headbox level. Th loss can be reduced by enlarging the stock lines and valves by installing a by-pass. We have, on occasion, temporari flowed a portion of the headbox stock directly over the scre discharge chamber into the headbox, thus making the lev about equal. Raising the level in the screens is not usual advisable since the tubs deteriorate rapidly when operat full.

The next step, of course, is to raise the headbox and screens. Care must be taken to check the effects on fan pump capacity and headbox walls. It may be necessary to speed up the pump to increase head and capacity, and straps may be required to strengthen headbox walls against increased hydraulic pressure.

If head-room limits the raising of your screens, there are several alternatives. When there is little air in your headbox stock, you may completely enclose the headbox, and pump directly to the slice. Or, you can pump directly to an airloaded headbox such as Beloit has built.

If you cannot increase your headbox pump capacity otherwise, it is quite possible to operate a smaller pump in parallel with it to give 1 to 2000 g.p.m. more flow. Friction losses and pump characteristics should be checked carefully for these new conditions to insure adequate net combined head and capacity.

Another factor which frequently limits speed on an existing machine is the drive. Where drive equipment is overloaded, one should first check all load factors to make certain that none are excessive. It is advisable to develop a check list of such factors for your operators so that each may exercise control over power usage on his machine. Some points to be included would be:

1. Water in driers—the installation of Visiflows in the condensate line will permit observation of condensate flow from each drier during operation. Plugs installed in drier heads near the shell will allow you to check for water in the drier without opening the manhole.
2. Heavily loaded doctors for creping or cleaning driers, wire rolls, and calenders. A doctor blade with a wide, worn heel will increase loads.
3. Bad bearings anywhere on the machine. Check for heat and roughness.
4. High flat box vacuum and filled fourdrinier wire.
5. Worn or grooved suction box covers.
6. Tight packing strips in suction rolls (press and couch).
7. Poor lubrication of suction roll packing.
8. Tight steam joints.
9. Tight chain drives.
10. Poor drive gear alignment.
11. Etc.

Having assured yourself that these load factors are all reasonable, it would be well to check the d.c. motor next if this type of drive is employed. The horsepower input to this motor is calculated from the very familiar formula

$$\text{hp.} = \frac{\text{volts} \times \text{amperes}}{746}$$

Your electrician is concerned primarily with the current, or amperes, for to him this means heat, and heat causes baked insulation and ultimate failure. In some cases it is possible to increase the voltage thereby securing the same horsepower input at a lower current input. Since voltage controls speed also, it may be necessary to change the drive sprocket to obtain a proper speed ratio; this is usually a relatively minor change. Your electrical equipment manufacturer will be glad to assign you with such recommendations.

Fortunately, most electrical equipment today is well made and will operate beyond nameplate ratings. With adequate ventilation most motors and generators will operate continuously up to 10% above rating; however, you must be certain that the heat from such overload is dissipated satisfactorily. Sometimes the overload must be reduced during hot weather, but even under these conditions it is surprising how much motor protection can be supplied by improved ventilation.

Undoubtedly operation in excess of rating reduces your factor of safety and makes both your electrician and the manufacturer unhappy since they are responsible for this equipment. However, such operation frequently can be looked upon as a "calculated risk" which is justifiable. Spare equipment, including an armature and field coils, naturally reduces the over-all risk. It is not recommended that you overload all your drive equipment by 10%, but I do suggest that arbitrary limitations are not always sound approaches, and under certain conditions a "calculated risk" may be in order.

Another approach to overcoming a drive capacity deficiency is more involved, however, in some cases, it can be justified by speed and production increases. Where you have adequate generator capacity, but are limited by a drive motor, it is possible to improve the situation by installing a "helper motor." This motor must have proper characteristics so it will follow the main drive motor without hogging the load and upsetting speed regulation. The manufacturer will check this feature for you. The helper motor may be connected to any convenient point and does not necessarily have to be tied into the main drive shaft directly.

All of these steps are of a temporary nature and will not eliminate the basic problem of an inadequate drive. However, in many cases it will be possible to increase machine speed considerably before new and heavier equipment becomes mandatory.

Another fundamental problem with old machines involves inadequate drying capacity. Since most of the equipment from the slice to the calenders is devoted to dewatering the sheet, it is obvious that the problem is quite extensive. To many people the term "drying" means only work done in the drier section itself, and hence they struggle with their driers in an attempt to solve all drying problems. Let us briefly review the influence of factors ahead of the drier section upon the work which must be done by the driers themselves. Following are two typical cases:

	Case 1	*Case 2*
Sheet dryness entering driers, %	28	30
Sheet dryness leaving driers, %	95	95
Pounds water evaporated per pound of paper, $\frac{72}{28} - \frac{5}{95} = 2.52$ $\frac{70}{30} - \frac{5}{95} = 2.28$		
Decrease in water evaporated, 0.24 lb. or 9.5%		

Thus, by increasing the dryness of the sheet entering the drier section by only 2%, the work of the driers is reduced almost 10%. Or, putting it another way, on a machine with 50 driers, it is equivalent to adding 5. This, combined with the high cost of removing water by evaporation, makes it important to do all possible water removal on the fourdrinier and in the press section to relieve the driers. You are in a far better position than I to outline methods for improving fourdrinier and press efficiency; however, the following points should be considered:

1. Number and size of table rolls in fourdrinier.
2. Vacuum carried on flat boxes.
3. Number of flat boxes.
4. Use of lump breaker on suction couch.
5. Felt design.
6. Felt cleanliness.
7. Dryness of felt ahead of nip, particularly last felt where water removal may be primarily a "blotting" action.
8. Density of press rolls.
9. Open area of suction press. A small hole in a soft rubber cover may squeeze shut in the pressure nip.
10. Use of saveall pans around press rolls to prevent water from throwing into felts.
11. Amount of vacuum. There is some question concerning the advantages of vacuums above 14 in.
12. Width of suction boxes in press rolls. On high-speed machines these must be increased in width.
13. Temperature on fourdrinier and press section. Steam improves drainage of glassine stock and increased water temperature can be a positive influence on any machine from a water removal standpoint.
14. Nature of furnish and stock freeness.
15. Number of presses.
16. Etc.

An important factor in drying which is frequently overlooked is sheet uniformity. In order to bring heavy and wet

W. D. Rice, P. H. Glatfelter Co.; J. P. Weidner, Container Corp. of America; Elmer Mitchell, Glassine Paper Co.; A. J. Haug, Scott Paper Co.; and C. M. Connor, W. C. Hamilton & Sons

streaks in a sheet up to the minimum dryness, it is necessary to overdry the remainder of the sheet. Steam used for overdrying is wasted and reduces machine speed accordingly. For many obvious reasons, every effort should be made to form a uniform sheet. Flow spreaders and numerous flow rectifiers are available for this purpose.

If the basic drying problem actually lies in the drier section, as it usually does, there are several approaches. First, you must insure complete water removal from your driers. Even a thin film of water inside the drier will retard heat flow drastically. Check the surface temperature of your driers with a surface pyrometer and compare this with the steam temperature. Any large difference probably indicates water in the drier. At high speeds scoops or dippers are no longer effective and it is necessary to resort to a steam blow-through to sweep condensate out of the drier. This, of course, means the bucket-type trap which empties when full, cannot be used since it does not permit a steam blow-through.

The most common failure of drier systems is lack of proper differential pressure across the driers, and particularly the steam joints. Two small pressure gages installed on each steam joint in the steam and condensate sections will tell you immediately whether a proper differential exists, and a Visiflow in the line will enable you to see at a glance whether water is moving freely.

Shell thickness is of major importance on large Yankee driers where the maintenance of a high rate of heat transmission is essential. In some cases drying can be increased by reducing this shell thickness. The increase in drying rate is almost directly proportional to the thickness reduction. As a matter of interest, the ideal Yankee drier is one whose shell is only thick enough to provide strength to carry its own weight, to resist the pressure roll loading and fatigue due to stress reversals, and to withstand the doctor action. It must have extra metal to permit resurfacing from time to time, and an adequate factor of safety must be provided. However, driers should not be made thicker than this minimum just to use higher steam pressures.

Allowable steam pressure increases directly with shell thickness, but the steam temperature does not increase directly with steam pressure. Since temperature differences control the rate of heat flow, you get more drying from a thinner shell even though you must necessarily reduce steam pressure. In some instances this explains the difference in drying rate between two Yankees which are identical in all other respects.

The use of air will, in many cases, increase drying rates and there are experts in the field to assist with the engineering of such applications. Two principles must be kept in mind in the use of air: (1) you cannot evaporate water into saturated air, and (2) moving air increases the rate of evaporation in proportion to the air velocity (not a direct proportion).

The misapplication of air has resulted in a number of disappointments and it is sometimes well first to spend a few dollars for a trial installation to prove your point. Even compressed air hoses will sometimes show you what can be expected in the way of increased dryness. You should also run dryness tests to determine the most desirable air temperature to use; many of you may find that air hoods operating at temperatures above 180 to 200°F. are not as efficient as those at lower air temperatures.

On occasion damp drier felts may be the cause of poor drying and additional felt driers, higher steam pressure, or air showers may alleviate the trouble.

In isolated and special cases infrared heating may find application to supplement drying capacity, but certainly not to replace steam drying.

There are many other factors which limit speed—some are real and others are matters of judgment. For example some of you may have placed arbitrary speed limitations on your machines due to open drier gears, bearing design, etc. I do not recommend that all arbitrary limitations be abolished but I do suggest that you review them carefully; and perhaps where maintenance is not excessive, a "calculated risk" is in order. We have been able to double the speed of several machines still operating on their original trunnion bearings and open drier gears. As a matter of information, alternate micarta drier gears will reduce noise and shock greatly while circulating lubrication systems and central fed bearings will do much to extend bearing life. Both should be considered as part of your speed-up program.

When machines begin to vibrate and sway at high speeds it is not always necessary to re-build the whole machine. Reinforce or renew obvious points of weakness. Cross-tie your machine frames and brace them to solid parts of the machine room. Grind your rolls true and balance them carefully. Align your rolls and gearing. You may be surprised how your machine settles down.

Undoubtedly there are other influences which are limiting your machine speed, but none are insurmountable if you approach the problem from the standpoint of 'How can it be done?" The initial reaction of most people to a problem is to outline 37 reasons why it won't work or can't be done. Thus, having partially salved their consciences by assuring themselves that the job is impossible, they sit back and do nothing. It usually takes perserverance and initiative to find how to do difficult jobs.

THE LOST TIME PROBLEM

So far we have discussed only machine speed. Usually, of equal importance, is machine lost time. Just as men are wont to pass off a new idea for a speed increase by citing reasons why it won't work, they find it equally easy to subscribe to the theory that lost time on a paper machine is essential to operations. No one will dispute the fact that no machine will run continually, but let's look at the reasons for lost time and see what might be done about each to improve the situation.

Cause of lost time	*Reduce down time by*
1. Machine snaps and breaks	Adequate maintenance
2. Clothing changes	Improved scheduling
3. Routine maintenance	Improved scheduling
4. Major shutdowns (maintenance and engineering changes)	Improved scheduling
5. Accidents	Adequate maintenance preventive maintenance

I think you will all agree that *adequate maintenance* and *improved scheduling* will at least minimize the above influences on lost time. I am not going to speak at length on this problem since it was covered in a paper last Fall entitled "Meet

Challenge of Maintenance and Lost Time in the Paper [illegible]." This paper was published so I will outline only the [illegible] points discussed.

Briefly, we have set up a maintenance control center under [illegible] direction of a maintenance planning engineer. This [illegible] trol system, as we have established it at Chester, has been successful, not only in reducing down time for clothing [illegible]nges by one third, but also in reducing maintenance, that [illegible] are extending it to other plants. All orders for maintenance or engineering changes pass through this center for [illegible]eduling purposes. The group is primarily concerned with [illegible]hing changes, but also schedules work for major machine [illegible] equipment shutdowns. They have established time requirements for both repetitive and special work projects; in [illegible] there are standard charts for each machine and each type [illegible] clothing change covering the sequence of operations and [illegible] allowances for routine work.

There are two fundamentals involved in sound scheduling: (1) determine the controlling project and reduce its time requirements to a minimum, and (2) provide adequate personnel, equipment, prefabrication, etc., to permit all secondary jobs to be done within this minimum time allowance.

Scheduling is done at a "work meeting" attended by representatives of all trades involved in the shutdown. In this manner all major interferences and complications are resolved prior to the shutdown.

During the shutdown the control center coordinates the over-all operation, revising the schedule and work load as necessary. It also notes time requirements and causes for delays so that a more realistic schedule can be established for the next shutdown.

If lost time and maintenance are problems with you, a conscientious job of scheduling will pay real dividends.

WASTE

The problem of high waste is usually a serious one, but it is so special in each mill that a general treatment is not possible. Let us only outline a few of the more obvious points to be considered: (1) excessive waste on turnovers (breaks, bad

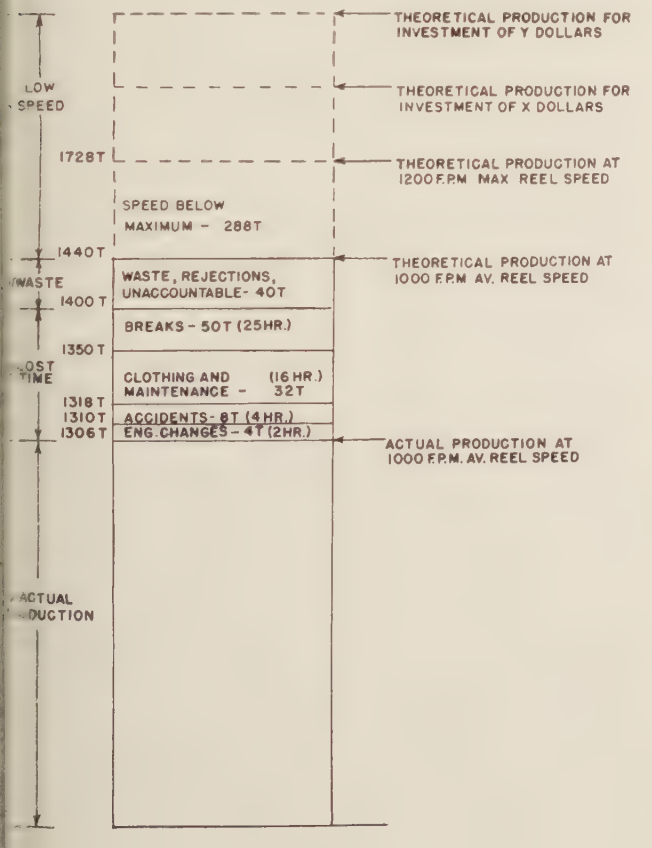
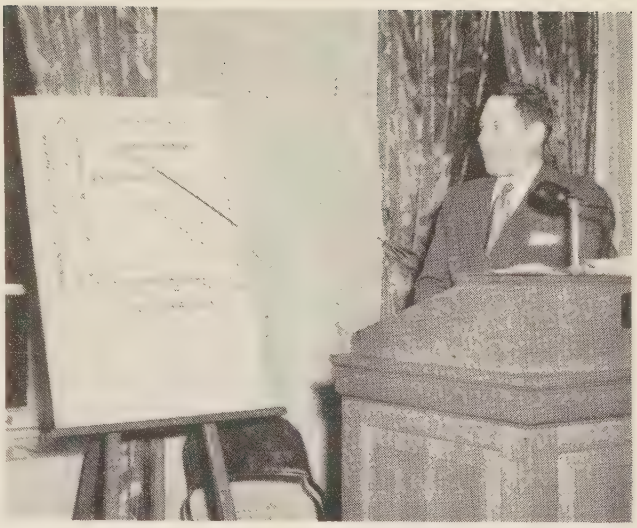


Fig. 1



Ward D. Harrison, Riegel Paper Corp., addressing the January meeting of the Delaware Valley Section of TAPPI

starts, sampling, etc.), (2) damage to rolls and finished product, (3) rejections for poor quality, (4) inability to run full width sheet (poor spread rolls, bad deckles), etc., (5) poor converting efficiency, (6) unaccounted losses, and (7) etc.

In our waste program, our first problem was to establish a means for measuring the loss due to each cause. This enabled us to plot a chart showing trends and the effects of changes. The second phase was the development of methods for reducing the losses to bare minimums, and this naturally was the most difficult assignment. The third step was one which is too often neglected: the training of personnel and follow-up. Unless your operators know what you are attempting to accomplish, and why, your program will never be a complete success.

SUMMARY

In conclusion I would like to say that most machines are not "all in." More production can be obtained at moderate investments by: (1) eliminating bottlenecks limiting speed, (2) reducing lost time by proper scheduling, and (3) reducing waste.

Give top priority to projects which will yield a quick return—not necessarily to the easy jobs.

In attacking any of these problems be certain that you have defined and stated the problem correctly; the solution is then a matter of straightforward engineering.

Finally, don't overlook the personnel factor and its influence on production. If your people believe in your objectives and understand your program, production will in many cases increase without the expenditure of a single dollar.

At the conclusion of this paper, the meeting was thrown open to a general discussion. A portion of the questions and Mr. Curtis' answers appear below.

Q. Why do you stress so heavily the importance of training mill personnel for these engineering changes?

A. Because the engineer in his enthusiasm for designing equipment often forgets that other people will have to make it work. The success or failure of the new design frequently depends upon how well it is understood by the machine operators. For that reason it pays to explain to them exactly what you are trying to do and how you expect to do it.

A. Usually not. They take pride in doing their jobs well and they realize that increased production will in many cases lead to production bonuses.

Q. When justifying engineering improvements within a 2-yr. amortization period, do you balance investment against savings before or after taxes?

A. In any case the 2-yr. figure is only a general yardstick. The final decision is made by management, not by the engineers and it depends upon market conditions, quality objectives, production budgets, and many other factors besides taxes.

UNITED STATES PATENTS ON PAPERMAKIN(

Fourth Quarter, 1952 — *Compiled by CLARENCE J. WES*

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

October 7, 1952

2,612,823. Carton erecting machine. Robert O. Woelfer, assignor to Container Equipment Corp., Newark, N. J. Filed Aug. 14, 1948. 3 claims. (Cl. 93-53.) The mechanism provides for automatically feeding initially flat cartons from a stack means for expanding or squaring the carton bodies and thus setting up the same in an open condition, and means for closing and sealing the ends.

2,613,022. Apparatus for sealing valved bags. William R. Peterson and Carl H. Hartman, assignors to St. Regis Paper Co., New York, N. Y. Filed March 20, 1947. 19 claims. (Cl. 226-48.)

2,613,024. Collapsible cellular carton. Kenneth T. Buttery, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed Jan. 22, 1947. 2 claims. (Cl. 229-28.) The patent covers the construction of an egg carton in which the cover is easily engaged in closing the carton and is very securely retained but may be easily disengaged by manual manipulation.

2,613,025. Package for frozen foods and the like. William A. Ringler, assignor to The Gardner Board and Carton Co., Middletown, Ohio. Filed Jan. 2, 1947. 2 claims. (Cl. 229-31.) A boxboard blank is combined with one or more sheets of protective filmlike substance, such as paper, glassine or preferably, moistureproof cellophane.

2,613,155. Viscosity-stable casein adhesives. Thomas A. White, assignor to National Starch Products, Inc., New York, N. Y. Filed May 26, 1949. 6 claims. (Cl. 106-138.) A stable type of casein adhesive contains not more than 10% by weight of an alkaline earth base or salt, such as barium hydroxide, strontium chloride, or calcium nitrate. These compounds increase the viscosity of the adhesive paste.

2,613,168. Label for re-usable bottles. Arthur I. Totten, Jr., assignor to Reynolds Metals Co., Richmond, Va. Filed April 14, 1949. 2 claims. (Cl. 154-46.) A flexible paper base is laminated to a metal foil; the foil has a gloss coating of cellulose nitrate and a synthetic resin; the label is decomposed in the normal washing of the bottles.

2,613,190. Preparation of sheet materials containing fibers, cork particles, and a rubberlike binder. David A. Feigley, Jr., assignor to Armstrong Cork Co., Lancaster, Pa. Filed Jan. 26, 1951. 7 claims. (Cl. 260-17.4) A product is formed from sulphite pulp, cork particles, and a butadiene-acrylonitrile copolymer which is suitable as an undercovering for rugs and especially for a low-cost gasket material.

October 14, 1952

2,613,579. Sizing and bleaching a wet web. Robert L. McEwen, assignor to Buffalo Electro-Chemical Co., Inc., Tonawanda, N. Y. Filed Aug. 27, 1947. 3 claims. (Cl. 92-40.) A partially dried sheet of pulp is treated with aqueous hydrogen peroxide made alkaline with sodium phosphate and a dispersion of wax (0.1 to 5% wax and 0.5 to 10% hydrogen peroxide) and the web is further dried at an elevated temperature.

2,613,672. Tobacco sheet material and method of producing the same. Paul A. Sartoretto and Joseph H. Carter, Jr., assignors to International Cigar Machinery Co., Flemington, N. J. Filed July 11, 1946. 9 claims. (Cl. 131-15.) A method is described for forming a sheet material from tobacco waste, viscose, and a salt of carboxymethylcellulose.

2,613,673. Tobacco sheet material and method of producing the same. Paul A. Sartoretto and Joseph H. Carter, Jr., assignors to International Cigar Machinery Co., Flemington, N. J. Filed July 11, 1946. 21 claims. (Cl. 131-15.) A sheet is formed from tobacco waste, sodium carboxymethylcellulose, and phosphoric acid.

2,613,741. Apparatus for cutting sheets from webs of carboard, paper, and the like. James E. Battersby, assignor t Masson Scott & Co. Ltd., London, England. Filed March 2 1950. 8 claims. (Cl. 164-68.) The invention is primaril concerned with the mounting of the feed rolls which supply wel to a plurality of cutters.

2,613,867. Carton. Harold W. Darr, assignor of 27.5% M. Josephine Darr, 22.5% to Howard F. Woo, and 22.5% Lolita Y. Woo, all of Minneapolis, Minn. Filed Aug. 3, 194 2 claims. (Cl. 229-37.) A handle for a folding box is formed the blank from which the carton is produced.

2,614,054. Paper reinforcing machine. Stephen J. Bais and Herman C. Lee, assignors to Thilmany and Paper C Kaukauna, Wis. Filed Nov. 8, 1949. 13 claims. (Cl. 15 1.76.) A machine is claimed which will lay upon a moving she of paper a substantially uniform thread pattern which may e tend across the full width of the sheet. Following the applic tion of the threads a second sheet of paper is applied and the a sembly is passed through compression rolls.

2,614,102. Steeping of cellulose. Paul H. Schlosser a Reid L. Mitchell, assignors to Rayonier, Inc., Shelton, Was Filed Feb. 23, 1950. 1 claim. (Cl. 260-233.) A method is d scribed for impregnating dry cellulose with a caustic soda steepi liquor.

October 21, 1952

2,614,349. Detachable-label bag. James G. Barnes, assign to Bemis Bro. Bag. Co., St. Louis, Mo. Filed June 17, 19 2 claims. (Cl. 40-2.) A labeled bag (especially a multi-p paper bag) can be salvaged for re-use by detaching the la without damage to the bag proper but which is not likely peel during the first use of the bag.

2,614,466. Container forming apparatus. Charles E. P mer, assignor to Package Machinery Co., East Longmead Mass. Filed Oct. 9, 1948. 6 claims. (Cl. 93-51.) An app tus is provided for folding a preformed blank into a conta and for effecting the engagement of locking elements which lock the container in a setup condition.

2,614,522. Coating machine for coating flexible she William T. Snyder, South Lancaster, Mass. Filed Sept. 1948. 2 claims. (Cl. 118-11.) An apparatus is described the roll coating of a flat sheet without subjecting the sheet any substantial bending or flexure which would distort the sh or tend to curl it.

2,614,655. Filter material. Sidney H. Katz, assignor to United States of America as represented by the Secretary War. Filed Aug. 10, 1943. 2 claims. (Cl. 183-44.) Me are provided for impregnating a filter paper with finely pulveri asbestos by means of air jets.

2,614,656. Deaerating a suspension of papermaking sto Carleton L. Clark and Carlo Vicario, assignors to The Rc reaed Corp., Bronxville, N. Y. Filed Aug. 15, 1949. 3 clai (Cl. 183-114.) An apparatus for the vacuum deaeration of p is described. It is claimed that all the air is removed except 0.1% by volume that is accepted as being unextractable.

2,614,715. Container partition structure. Cyril R. R assignor to Ross Bros. (Ben Rhydding) Ltd., Ilkley, Engla Filed April 1, 1949. 5 claims. (Cl. 220–22.) The invent covers a partition structure for insertion into a receptacle to vide it into a plurality of compartments.

2,614,737. Can carrier with foldable handle. George Parker, assignor to Container Corp. of America, Chicago, Filed Aug. 24, 1950. 3 claims. (Cl. 224-45.) A can carrier an integral centrally disposed partition so constructed that handle portion can be folded against the top of the carrier with imparing the subsequent efficiency of the carrier.

2,614,745. Divisible carton. Clifford D. Fallert and Ge E. Whalley, assignors to Gaylord Container Corp., St. Lo Mo. Filed Feb. 3, 1947. 1 claim. (Cl. 229-27.) A comple sealed one-piece rigid carton consists of a pair of divisible sm connected-together rigid cartons, suitable for shipping carton canned or bottled goods.

2,614,746. Carton. William P. Frankenstein, Cincin

nio. Filed Oct. 9, 1947. 5 claims. (Cl. 229-33.) The in-n ion covers a knock-down type of container.

2 614,922. Methods of dewaxing paper. Henry B. Hope, ignor to R. H. Comey Co., Inc., Brooklyn, N. Y. Filed Nov. 947. 5 claims. (Cl. 92-1.6.) A three-step dewaxing proc-consists in treating the paper at 95°C. with water containing conol NR and sulphuric acid, treating the residual paper with im chlorite in water, and then again heating at 95°C. with conol NR and sulphuric acid.

2 614,923. Digester filling in sulfate pulping. Oma Tark-n, assignor of one half to Sunila Osakeyhtio, Sunila, Finland. Feb. 1, 1947. 2 claims. (Cl. 92-7.) A sulphate digester rged with chips and black liquor under pressure.

2 614,924. Composition for fabricating paper and a process of ing it. Bernard Chiego, assignor of 10% to Frank Gardner, more, Md., and 80% to Albion D. T. Libby, Newark, N. J. March 8, 1949. 6 claims. (Cl. 92-14.) A method of sting corncobs or bagasse with a 1% solution of sodium oxide at 212 to 220°F. gives a product which can be mixed wood pulp for the manufacture of paper.

614,979. Drilling fluid. William M. Hutchinson, assignor hillips Petroleum Co., Bartlesville, Okla. Filed Aug. 18, 17 claims. (Cl. 252-8.5.) The drilling fluid contains the ion product of a nitrogen-containing organic base (tri-nolamine, ethylenediamine, and the like) with derivatives of ose.

October 28, 1952

615,329. Paper stock analyzer. George S. Witham, nor to The Bristol Co., Waterbury, Conn. Filed July 16, 3 claims. (Cl. 73-63.) An apparatus is designed for the ltaneous determination of the consistency and freeness of ng paper stock.

615,339. Apparatus for sampling pulp. Sigbjörn P. H. E. ersson, Ockelbo, Mac S. Rudberg, and David R. Rydberg, vik, Sweden. Filed Nov. 2, 1948. 1 claim. (Cl. 73-423.) mpling tube is designed to be inserted into a digester wall r the withdrawal of pulp samples.

2 615,374. Slice assembly for papermaking machines. Ber-d A. Malkin, assignor to Dominion Engineering Works Ltd., hine, Quebec, Canada. Filed Oct. 4, 1948. 19 claims. (Cl. 92-44.) A method of mounting a slice plate is proposed by eans of which it has a wide range of adjustment both with re-ect to its elevation and its position along the length of the four-inier wire or other sheet-forming element.

2,615,375. Apparatus for separating conjointly gathered bag be walls. William W. Rowe, Carroll L. Spangler, and Roy C. ick, assignors to Cincinnati Industries Inc., Lockland, Ohio. led Aug. 24, 1948. 5 claims. (Cl. 93-8.) The purpose of the vention is to separate the walls of a bag tube in a continuous gth and by continuously action means.

2,615,376. Device for automatically removing window cut-ts from blanks. Alexander Pelikan, assignor to Federal Carton rp., North Bergen, N. J. Filed June 9, 1949. 2 claims. (Cl. 93-36.) An apparatus is described for automatically strip-ng the cutout areas of blanked sheets as they are individually d successively fed from the die-cutting means in a continuous eration.

2,615,377. Apparatus for making sealed packages. Robert Farrell, William G. Mueller, and August Bartes, Jr., assignors Marathon Corp., Rothschild, Wis. Filed May 10, 1949. 11 laims. (Cl. 93-36.01.) The patent covers an apparatus for serting and sealing flexible membranes in the end of rectangular per cartons and the like. The membrane may be heat sealed the inner walls of the carton.

2,615,378. Apparatus for assembling multiple part egg con-iners and the like. Samuel Bergstein, Cincinnati, Ohio. led Nov. 14, 1950. 5 claims. (Cl. 93-37.) The machine is r assembling an egg container which comprises an outer band ember and an inner partitioning element of double thickness hich are adhesively secured together.

2,615,481. Oscillating manifold hydraulic log barker. Freder-k W. Horstkotte, Portland, Ore. Filed Nov. 10, 1950. 8 laims. (Cl. 144-208.) In an oscillating manifold hydraulic g barker, means are provided to improve the surface coverage r coordinating the forward speed of the log with the frequency oscillation of the nozzle streams over the surface.

2,615,518. Sheet cutter. Lloyd Hornbostel, assignor to eloit Iron Works, Beloit, Wis. Filed May 1, 1947. 4 claims. (Cl. 164-68.)

2,615,525. Sound-absorbing board with holes containing de-as material. Erling Berner, Gothenburg, Sweden. Filed July , 1947. 4 claims. (Cl. 181-33.) It is proposed that a por-n of the material loosened by the borers (operating at about 00 r.p.m.) remains at the bottom of the holes.

2,615,610. Container with reclosure and shield device. thur J. White, assignor to American Can Co., New York, Y. Filed Dec. 26, 1947. 5 claims. (Cl. 229-7.) In a can with a metal end, provision is made so that the raw edge left by pressing inwardly a scored portion of the cover to provide a dispensing opening is shielded to protect the user from injury.

2,615,611. Chick shipping container. Philip F. Paul and Ronald Capps, assignors to The Patent and Licensing Corp., New York, N. Y. Filed April 19, 1941. 2 claims. (Cl. 229-15.) The crossed partitions are so constructed as to prevent the possibility of the chicks having their toes pinched between the bottom edges of the partitions and the surfaces of the bottom member of the container.

2,615,612. Carrier for columnar articles. Oscar L. Vines, New York, N. Y. Filed June 21, 1951. 7 claims. (Cl. 229-28.) A blank is described in which the carrier walls and partitions are of double thickness and in which the strength is augmented by an intermediate glue layer.

2,615,613. Container with telescoping closure. Harry C. Reeser, assignor to The Patent and Licensing Corp., New York, N. Y. Filed March 25, 1949. 3 claims. (Cl. 229-43.) In a container, consisting of a body portion and a cover member which partially or entirely telescopes over the body portion, the construction is such that, in gripping the hand holes in the cover, the loaded body portion will also be held.

2,615,614. Fungus inhibiting container for peat moss and the like. Frank R. Linda, assignor to St. Regis Paper Co., New York N. Y. Filed Aug. 25, 1948. 12 claims. (Cl. 229-55.) The wet-strength paper bag is impregnated with a suitable fungicidal agent, such as mercury compounds, chlorinated phenols, and metallic naphthenates.

2,615,749. Bottle carrier. Joseph C. Kuchel, Arlington, Va. Filed July 25, 1950. 5 claims. (Cl. 294-87.) The bottle-carrying cells are so formed that bottles may be picked up and dropped through the lower end of the carrier.

2,615,750. Bottle carrier. William L. O'Sullivan, Milwaukee, Wis. Filed Sept. 3, 1948. 1 claim. (Cl. 294-87.28.) A cardboard bottle carrier is so designed that it can be slipped over bottles in their normal position in the case.

2,615,806. Method of making rigid type felted mineral wool product. Frank L. Marsh, Carl J. Koehler, and Willard L. Chrisler, assignors to National Gypsum Co., Buffalo, N. Y. Filed April 12, 1947. 4 claims. (Cl. 92-21.) A rigid-type insulation product is formed from mineral wool, paper pulp, asphalt, a wetting agent, and water.

2,615,822. Method of making sheet or web material. William C. Huebner, New York, N. Y. Filed Feb. 21, 1946. 7 claims. (Cl. 117-47.) A method is described for the formation of sheets or webs, the material containing electrically chargeable substances. The material is deposited on a movable support by the lines of force of an electric field created at a predetermined location relative to the support.

2,615,883. Production of lignin, cellulose, and pentosans. Orland R. Sweeney, Melvin H. Brown, and Lionel K. Arnold, assignors to Iowa State College Research Foundation, Ames, Iowa. Filed Sept. 19, 1947. 16 claims. (Cl. 260-124.) Agricultural residues are digested with a dilute mixture of sulphuric, nitric, and hydrochloric acids; the spent cooking liquor may be used for the production of furfural or pentose sugars. The solid residue is digested with sodium hydroxide to remove the lignin, leaving cellulose as the final residue.

November 4, 1952

2,616,340. Apparatus for pulping papermaking material. William V. Knoll, Dayton, Ohio. Filed Feb. 1, 1949. 3 claims. (Cl. 92-26.) An apparatus for disintegrating pulp in sheet or lap form or waste materials consists of a round or square vessel or tank with an inverted frustoconical bottom in the case of the round vessel or an inverted pyramidal bottom in the case of the square tank. Circulation is effected by two or more impeller units mounted on the angular or sloping portion of the vessel; these are driven at comparatively high speed by individual motors.

2,616,341. Carton folding apparatus and method. Heinz Ahlmeyer and Whitney D. Sherman, assignors to Robert Gair Co., Inc., New York, N. Y. Filed Sept. 30, 1947. 15 claims. (Cl. 93-37.) An apparatus is described for folding cartons of the bottle-carrier type designed to carry four or more bottles. These are formed from a single sheet of material.

2,616,610. Dispensing container. Harry A. Tomarin, assignor of 50% to J. Warren Kinney, Jr., Cincinnati, Ohio. Filed April 1, 1947. 4 claims. (Cl. 229-17.) A one-piece container has formed integrally therewith an inclined dispensing panel which spans the adjacent portions of the top and front panels.

2,616,611. Bottle carrier. Edwin L. Arneson, assignor to Morris Paper Mills, Chicago, Ill. Filed Sept. 23, 1949. 9 claims. (Cl. 229-28.) A bottle carrier is characterized by side walls, a central upright partition and suspending panel disposed medially of said walls, and a plurality of partitions.

2,616,612. Mailing card. Joseph M. Guttman, Brooklyn, N. Y. Filed Sept. 7, 1951. 4 claims. (Cl. 229-92.8.) The

mailing card has a detachable portion which can be used as a credit card.

2,616,689. Web feeding mechanism for carton blank forming machines. John R. Baumgartner, Milwaukee, Wis. Filed Oct. 17, 1949. 3 claims. (Cl. 271-2.4.) The patent covers a machine in which a web of paper from a supply roll is intermittently fed into and out of a creasing and cutting or blank-forming press from a pair of intermittently active feed rolls to which the paper is fed by continuously active metering feed rolls.

2,616,792. Manufacture of chlorine dioxide. Henry C. Marks and Robert R. Joiner, assignors to Novadel-Agene Corp., Belleville, N. J. Filed April 1, 1949. 8 claims. (Cl. 23-152.) The manufacture of chlorine dioxide by the passage of dilute nitrogen dioxide (about 5%) into aqueous chlorate solution is claimed.

2,616,802. Fiberizing lignocellulose steamed under pressure and apparatus. Richard D. Kehoe, Alphonse Surino, and Ronald G. Goodwin, assignors to Pandia, Inc., New York, N. Y. Filed July 28, 1949. 8 claims. (Cl. 92-6.) This covers a modification of the Asplund apparatus and of the Beveridge and Kehoe U. S. patent 2,323,194 (June 29, 1943).

2,616,814. Composition of calcium salts of tall oil and a method of making it. Paul Mahler, New York, N. Y. Filed Sept. 30, 1949. 2 claims. (Cl. 106-123.) Tall oil in mineral spirits is heated with hydrated lime; the product can be used with a pigment, an extender, or other material to form a coating composition.

2,616,818. Paper coating. Julian L. Azorlosa, assignor to Hercules Powder Co., Wilmington, Del. Filed Nov. 18, 1948. 3 claims. (Cl. 117-155.) The coating agent consists of an aqueous dispersion of clay containing 6 to 10% polyacrylamide as an adhesive; glyoxal is used as an insolubilizing agent.

2,616,823. Laminated panel. Lawrence B. Weymouth, assignor to Briggs Manufacturing Co., Detroit, Mich. Filed Jan. 30, 1948. 14 claims. (Cl. 154-106.) The panel consists of a foundation board, a layer of padding, and a covering layer of cloth or other suitable material, bonded together through resin in a low-density, relatively thick paper or pulp sheet interposed between the board and the padding.

November 11, 1952

2,617,205. Siphon for driers. Hervey G. Cram, Appleton, Wis. Filed Sept. 13, 1950. 10 claims. (Cl. 34-124.) In a siphon arrangement, means are provided for the positive alignment of the steam-joining body with the clamping ring carried by the cylinder trunnion and with the pivotal slip ring disposed between the body and the trunnion.

2,617,334. Pulper for paper stock. William K. Kolb and Samuel W. Pollock, assignors to Valley Iron Works Co., Appleton, Wis. Filed April 19, 1947. 2 claims. (Cl. 92-26.) The pulper, in which the circulation of the stock is positively controlled during the pulping operation, consists of a large tank supported on a frame, rotor means for circulating and breaking up the stock, baffles, and feed-screw means for controlling the recirculation of the stock so as to insure numerous contacts of undisintegrated pulp with the rotor.

2,617,521. Packaging buffing compound and like materials. Ellsworth T. Candee, Watertown, Conn., assignor to The Lea Manufacturing Co. Filed March 5, 1949. 1 claim. (Cl. 206-56.) A container for a buffing compound consists of cylindrical paperboard side walls lined with a layer of substantially nonporous, moisture-impermeable material with no tendency to adhere to the buffing compounds.

2,617,524. Master shipping container. Leon J. Rosenberg, assignor to Gaylord Container Corp., St. Louis, Mo. Filed June 11, 1949. 3 claims. (Cl. 206-65.) A container for shipping in stack formation a multiplicity of relatively small packages each containing a plurality of rayon yarn cones held upright in horizontally spaced relation.

2,617,528. Automatic sheet throwout apparatus. Lawrence A. Moore, assignor to American Coating Mills Corp., Elkhart, Ind. Filed July 29, 1946. 20 claims. (Cl. 209-111.) Means are provided for detecting the presence of a defect in a web or strip of paper before it is cut into sheets and for discarding automatically the sheet containing the defect. Light-sensitive means are employed to detect the defect.

2,617,576. Prelined container having multiple cells. Robert M. Bergstein, assignor to Robert M. Bergstein and Frank D. Bergstein, Cincinnati, Ohio, as trustees. Filed Jan. 24, 1945. 6 claims. (Cl. 229-14.) Prelined containers have two or more individual cells or compartments which can be employed for packing different increments of the same content or for contents of diverse character.

2,617,577. Ray O. Tardiff, assignor to Breyer Ice Cream Co., Philadelphia, Pa. Filed Nov. 22, 1949. 1 claim. (Cl. 229-15.) The package consists of a conventional paper carton member and a tray member to be inserted within the carton; it is designed for cup cakes, ice-cream tarts, and the like.

2,617,578. Carton construction. Howard J. Fischer, assignor to The United States Printing and Lithograph Co Norwood, Ohio. Filed Dec. 9, 1949. 5 claims. (Cl. 229-16 The invention relates to a preformed blank for folding into container for displaying crayons or the like.

2,617,579. Collapsible lined tray or carton. Kenneth T Buttery, assignor to Sutherland Paper Co., Kalamazoo, Mich Filed Feb. 14, 1949. 5 claims. (Cl. 229-35.) The body por tion is formed of an integral blank and the liner is formed of sheet superimposed thereon.

2,617,580. Self-locking folding box. Reginald B. Melle assignor to Bemiss-Jason Co., San Francisco, Calif. Filed Nov 10, 1948. 13 claims. (Cl. 229-36.) The invention provide for the formation, without the use of adhesives, of a rigid an smooth box corner free from projections.

2,617,581. Popcorn box with pouring spout. Sharrell I Smith, Ashland, Ohio. Filed May 26, 1947. 1 claim. (C 229-39.)

2,617,606. Method of rewinding paper core waste. Marvi C. Whatmore, Norwalk, Conn. Filed Feb. 27, 1952. 1 claim (Cl. 242-58.) Unwound paper remaining on the core of a spe supply roll is spliced to the paper on a fresh supply roll while th rolls are in position on the reel.

2,617,607. Winding machine. Thomas N. Carter and Alex ander D. Frascella, assignors to Cameron Machine Co., Brooklyn N. Y. Filed Dec. 23, 1949. 6 claims. (Cl. 242-66.) A mecha nism is provided which relieves the operator of the necessit of manually elevating the riding roller between winding operation

2,617,608. Winding machine. Thomas N. Carter, assigno to Cameron Machine Co., Brooklyn, N. Y. Filed Dec. 2 1949. 7 claims. (Cl. 242-66.) The roll of material being woun on the winding shaft will be constrained with the valley betwee the winding rollers as the winding operation proceeds and th diameter of the roll being wound increases.

2,617,711. Process of making calcium carbonate. Robe W. McAllister, Carlisle, Mass. Filed April 30, 1949. 11 claim (Cl. 23-66.) The method consists in reacting limekiln exhaus gases containing lime dust, limestone, and carbon dioxide wit fine particles of water.

2,617,743. Method of making coated paper moisture resistan Richard J. Grimm, assignor to St. Regis Paper Co., New Yor N. Y. Filed March 8, 1952. 3 claims. (Cl. 117-64.) method is described for the incorporation of formaldehyde int the steam shower in connection with the coating of paper wit clay and casein, soybean protein, and the like.

2,617,776. Coating compositions. Paul E. Marling, assigno to Monsanto Chemical Co., St. Louis, Mo. Filed Oct. 25, 194 8 claims. (Cl. 260-22.) The coating composition consists o 25 to 90% by weight of an alkyd resin having an acid number o 0 to 20 and 10 to 75% by weight of vinyl esters of tall oil.

2,617,791. Recovery of valuable products from pentaeryth ritol mother liquor. Walter O. Snelling, assignor to Troj Powder Co., Allentown, Pa. Filed Sept. 15, 1949. 5 claim (Cl. 260-97.5.) The mother liquor is treated with tall oi the resulting product is useful as a varnish, printing ink, etc.

2,617,792. Disproportionation of rosin acids and fatty acid Don E. Floyd, assignor to General Mills, Inc., Minneapoli Minn. Filed Sept. 5, 1950. 9 claims. (Cl. 260-97.5.) Ta oil or the rosin acid fraction is heated with a nickel catalyst in carbon dioxide atmosphere for three hours at 250°C. The proc ucts are suitable as emulsion stabilizers.

November 18, 1952

2,618,110. Art of packaging. John S. Donnell, assignor t Florida Fibre Box Co., Sarasota, Fla. Filed April 30, 194 2 claims. (Cl. 53-16.) A container for cut flowers and a metho of packaging are described.

2,618,205. Papermaking machine. Ralph C. Heys, assigno to Beloit Iron Works, Beloit, Wis. Filed March 8, 1948. claims. (Cl. 92-49.) The patent relates to a suction roll opera ing with at least two press rolls.

2,618,206. Suction box cover. Joseph P. Van Ryzin, a signor to Appleton Wood Products Co., Appleton, Wis. File Oct. 3, 1949. 3 claims. (Cl. 92-51.) The suction box cover constructed of cross members and interfitting vertical woode blocks.

2,618,208. Box assembly rack. Oscar H. Williamson, a signor to International Paper Co., New York, N. Y. Filed Ma 26, 1951. 4 claims. (Cl. 93-39.1.) An assembly rack for box includes three sets of deflector or folding shoes to affecting th folding of the box section cap and a supporting cage that effec the assembly of the box section by placing the component par in the rack in proper sequence—cap, inner end pad, outer short telescoping sleeve, and inner longer telescoping sleeve.

2,618,428. Shock resistant container. John K. M. Harriso Gainesville, Va. Filed Jan. 27, 1947. 2 claims. (Cl. 229-5.6 The patent covers the end structure of a cylindrical container fo liquid which has a marked resistance to mechanical shock.

2,618,429. Shipping containers. John S. Donnell, assignor t Florida Fibre Box Co., Sarasota, Fla. Filed Sept. 7, 1950.

ims. (Cl. 229-45.) Shipping containers for fruit, vegetables, ther articles have a releasable locking arrangement for secur- he cover.

2 618,596. Oil soluble gelling agent. Arthur Minich and Mil- Nowak, assignors to Nuodex Products Co., Inc., Elizabeth, J. Filed June 7, 1950. 6 claims. (Cl. 252-8.55.) A gelling t for greases, lubricating oils, kerosene, and coating agents is ed from a mixture of 20 to 80% of tall oil and 80 to 20% conut fatty acids by treatment with aluminum sulphate.

2 618,610. Methods of regenerating a spent liquor resulting the digestion of a cellulose-lignin complex. Alfred M. nsen, San Francisco, Calif. Filed Sept. 2, 1947. 1 claim. 252-183.) A method of recovering values from a neutral ite semichemical spent liquor is outlined. The liquor is rated with carbon dioxide which precipitates the lignin; then saturated with sulphur dioxide, which precipitates fur- organic material. A portion of the filtrate is causticized to sodium hydroxide and calcium sulphite; the remainder is mposed with sulphuric acid, liberating sulphur dioxide and g a solution from which vanillin and acetic acid can be re- red; the residual liquor is then concentrated and calcined g calcium sulphate and soluble sodium sulphate. A flow- of the process is given.

November 25, 1952

2 618,807. Arrangement for cooling of porous fibrous boards. G. V. Ingve, assignor to Svenska Fläktfabriken A B, Stock- , Sweden. Filed March 29, 1949. 5 claims. (Cl. 15-302.) us boards are cooled by sucking air through them, making use suction box with a plane suction opening and an endless wire n consisting of a closed and an open portion in series.

2 618,813. Method for making cellulosic board. Edward A. on and Forrest F. Bell, assignors to Curtis Companies Inc., ton, Iowa. Filed Sept. 14, 1950. 3 claims. (Cl. 18-47.5.) ixture of granulated wood and as little as 4% of a resinous er is pressed in flat pan or traylike molds; the pressure is lated with the moisture content of the mixture.

2 618,887. Convertible carton. William P. Frankenstein, cinnati, Ohio. Filed July 15, 1947, 13 claims. (Cl. 46-11.) hollow wall box can be used as a shipping and display package d then as a toy building.

2,618,963. Tube testing machine. Robert E. Wagenhals, signor to The Timken Roller Bearing Co., Canton, Ohio. ed April 4, 1949. 2 claims. (Cl. 73-37). A test for the im- ct load capacity of the capped end of a shipping tube made of ound paper consists in directing a blast of air against the end.

2,618,966. Mechanism responsive to variations in the con- itency of a fibrous suspension. Karl A. Karlsson, Dals Langed, veden. Filed June 17, 1947. 6 claims. (Cl. 73-54.) The nstruction of a consistency regulator is claimed.

2,619,011. Paper machinery. Stephen A. Staege, assignor to he Black-Clawson Co., Hamilton, Ohio. Filed July 23, 1947. laims. (Cl. 92-44.) A stock inlet is capable of delivering the ock to the forming member of a paper machine under controlled nditions of substantially uniform velocity across the width of he machine.

2,619,012. Method of making loud-speaker diaphragms. seph B. Brennan, Cleveland, Ohio. Filed Aug. 5, 1947. 2 laims. (Cl. 92-54.) The fibers are deposited on a porous mold ate which is subjected to a vacuum on its lower side; a plunger ember can also be used.

2,619,227. Packaging system. Charles J. Arthur, Westport, nn. Filed Jan. 23, 1950. 13 claims. (Cl. 206-56.) A thod is described for packaging electric light bulbs and like icles.

2,619,247. Label applying machine. Rene J. Gaubert, kland, Calif., assignor to Simplex Packaging Machinery, Inc. led March 10, 1948. 2 claims. (Cl. 216-29.) The machine ts labels from a continuous roll and centers and seals the label the web of material as it is supplied to the bag-making machine.

2,619,275. Folding box employing nonscorable sheeting. bert M. Bergstein, Cincinnati, Ohio. Filed Jan. 6. 1947. laims. (Cl. 229-31.) Carton bodies made of panels of cellu- se acetate and the like have end pieces formed of boxboard or her scorable material.

2,619,276. Container. Clyde F. Gibbons, assignor to Gay- rd Container Corp., St. Louis, Mo. Filed March 6, 1950. laims. (Cl. 229-33.) The patent covers a method of locking over by means of a T-shaped tab.

2,619,277. Multiply window bag. Harold F. Shumann, ttsburgh, Pa. Filed Dec. 13, 1948. 1 claim. (Cl. 229-55.) he bag consists of an inner ply of relatively translucent material d an outer ply of transparent material.

2,619,407. Sulfur recovery. Marvin J. Udy, assignor to aranty Investment Corp., Ltd., Montreal, Canada. Filed ec. 9, 1946. 14 claims. (Cl. 23-224.) A method is described the recovery of sulphur from pyrites.

2,619,411. Apparatus for the recovery of chemicals and heat om residual liquor. Leslie S. Wilcoxson, assignor to The Bab- cock & Wilcox Co., New York, N. Y. Filed Sept. 29, 1948. 6 claims. (Cl. 23-262.) A method is described for the combustion of magnesia-base spent sulphite waste liquor.

2,619,428. Process for modifying starch with aluminum chloride and enzyme and applications of such modified starch. Ralph W. Kerr, assignor to Corn Products Refining Co., New York, N. Y. Filed March 1, 1950. 40 claims. (Cl. 106-214.) Starch is treated with aluminum chloride at a pH of 2.8 to 3.4 and then with an enzyme at a pH of 5.5 to 7.5.

2,619,483. Production of alkali cellulose. Merlyn H. Wilcox, John Dowring, and James G. N. Drewitt, assignors to Celanese Corp. of America, New York, N. Y. Filed Sept. 28, 1948. 1 claim. (Cl. 260-233.) Pulp with a packing density of about 26 lb./cu. ft. and an equal weight of sodium hydroxide in 20 parts of monomethyl glycol are passed through a Werner-Pfleiderer mixer; the product is suitable for forming esters or ethers of cellulose.

December 2, 1952

2,619,681. Method of making cellulose boards. Merle W. Baker, Forrest F. Bell, Charles F. Curtis II, and Edward A. Patton, assignors to Curtis Co., Inc., Clinton, Iowa. Filed May 5, 1951. 6 claims. (Cl. 18-47.5.) This is very similar to U. S. patent 2,618,813 (Nov. 25, 1952) and relates to the molding of a mixture of granulated wood and a resinous binder.

2,619,882. Carton erecting machine. James O. Rohdin, assignor to Esselte förpackning ab, Norrköping, Sweden. Filed Aug. 31, 1950. 2 claims. (Cl. 93-53.) The apparatus permits the feeding of cartons to a carton carrier and the subsequent extending of the cartons.

2,620,014. Apparatus for making laminated articles. Fred Lyijynen, assignor to Briggs Manufacturing Co., Detroit, Mich. Filed March 24, 1948. 14 claims. (Cl. 154-1.) Panels for the trimming of the interiors of automobiles are formed by a laminating operation.

2,620,015. Web reinforcing machine. Allan B. Stevenson and William H. Cannard, assignors to American Reenforced Paper Co., Attleboro, Mass. Filed April 13, 1948. 9 claims. (Cl. 154-1.7.) A method of applying sisal or like fibers to a web of paper coated with asphalt or other adhesive is improved by modifying the carrier bars and the doffing mechanism which actuates the bars.

2,620,116. Double-wall carton. Linus J. McDonough, assignor to Corson Manufacturing Co., Lockport, N. Y. Filed March 8, 1950. 2 claims. (Cl. 229-14.) A double-walled container consists of a single sheet of material which, when folded, produces a smaller box held firmly in spaced relationship within a larger box.

2,620,117. Pallet load divider tray. Paul A. Nemoede, assignor to Container Corp. of America, Chicago, Ill. Filed June 9, 1950. 1 claim. (Cl. 229-30.) This patent relates to a divider tray for pallet loads which is re-usable and collapsible for storage or return for re-use.

2,620,118. Breadbox. Eugene F. Lillie, assignor to A B C Corrugated Box Co., Minneapolis, Minn. Filed June 22, 1949. 2 claims. (Cl. 229-42.) A container for packing hot bread is claimed which is transported without noticeable shrinkage.

2,620,119. Shipping container. Walter C. George, assignor to Gaylord Container Corp., St. Louis, Mo. Filed July 23, 1951. 6 claims. (Cl. 229-45.) A container is described for shipping nails and other articles of hardware.

2,620,120. Bag closure with label. Emil Andersen, assignor to Century Engineering Co., Chicago, Ill. Filed June 23, 1949. 1 claim. (Cl. 229-62.) A method is described for the preattachment of labels to bags of heat-sealing materials.

2,620,121. Device for closing and sealing of valves in valve bags. John Johnsson, assignor to Billeruds Aktiebolag, Säffle, Sweden. Filed Feb. 2, 1948. 4 claims. (Cl. 229-62.5.)

2,620,141. Winding machine for paper rolls. Georg Langbo, Gulskogen, Norway. Filed April 1, 1947. 5 claims. (Cl. 242-56.) The winder has two or more spindles for the consecutive winding of paper rolls, each spindle having means for cutting the web, gluing the free end of the web, and expulsion of the roll.

2,620,260. Methods of making chlorine dioxide. Sven U. Ekman, assignor to Mo och Domsjö Aktiebolag, Ornsköldsvik, Sweden. Filed Jan. 8, 1948. 2 claims. (Cl. 23-152.) Chlorine dioxide is formed from a metallic chlorate and sulphur dioxide.

2,620,271. Deinking waste paper containing groundwood. Harold T. Ruff and James F. Stevenson, Jr., assignors to The Mead Corp., Chillicothe, Ohio. Filed July 24, 1945. 3 claims. (Cl. 92-1.5.) Waste paper containing mechanical pulp is treated with 2 to 3% of sodium hydroxide for 2 to 4 hr. at 90 to 110°F. and then bleached with calcium or sodium hypochlorite.

2,620,316. Soya protein paper containing methylated melamine formaldehyde resin. Daniel D. Ritson, assignor to American Cyanamid Co., New York, N. Y. Filed Aug. 20, 1949. 4 claims. (Cl. 260-6.) A coating composition contains soybean protein and about 4% by weight (based on the protein) of a water-soluble methylated melamine-formaldehyde resin which

will heat cure at moderately low temperatures to a water-insoluble condition.

December 9, 1952

2,620,711. Hydraulically operated duplex box machine. Wallace Lindsay, Amsterdam, N. Y. Filed July 20, 1949. 29 claims. (Cl. 93-51.) The invention relates to an automatic box-forming machine which comprises two gluing and two forming means arranged to be actuated from a common power source.

2,620,842. Bag construction. Arthur D. Hoeppner and Richard D. Hayes, assignors to Bemis Bro. Bag Co., Minneapolis, Minn. Filed Sept. 21, 1950. 1 claim. (Cl. 150-7.) A transverse band is secured only at its opposite side edges to one of the wall-forming elements of a bag to provide a handle therefor.

2,620,851. Inorganic sheet material. Alfred W. Brown, assignor to Owens-Corning Fiberglas Corp., Rochester, N. Y. Filed July 9, 1949. 4 claims. (Cl. 154-2.6.) Asbestos fiber webs are reinforced by interwoven glass fiber yarns.

2,620,854. Machine for making cushioned pads. Russell A. Wetherell, assignor to The Mason Box Co., Attleboro Falls, Mass. Filed Sept. 30, 1948. 4 claims. (Cl. 154-41.) A machine is claimed for applying a flexible covering material of ornamental character to a relatively stiff backing member; the product is suitable as a jewelry box.

2,620,961. Carton flap opener. Eugene A. Wahl and Ralph J. Winters, assignors to P. Ballantine & Sons, Newark, N. J. Filed Dec. 21, 1951. 4 claims. (Cl 226-129.) Loose carton flaps are unfolded from the closed position by fluid pressure.

2,620,962. Package or container. Gerry Powell, assignor to Bernard B. Workman, New York, N. Y. Filed May 31, 1951, 6 claims. (Cl. 229-34.) A container is designed for packaging candy canes or sticks.

2,620,963. Container. Vahan Hagopian, assignor to The Plastic Barrel Corp., New York, N. Y. Filed Dec. 17, 1948. 13 claims. (Cl. 229-67.) This is a continuation of U. S. patent 2,460,820 (Feb. 8, 1949) and relates to a hollow body (barrel) consisting of two sets of nested cup-shaped plies formed from resin impregnated fibrous material.

2,620,964. Package. Alfred G. Rose and Joseph A. Gilbert, assignors to Rose Brothers (Gainsborough) Ltd., Gainsborough, England. Filed Oct., 30, 1947. 2 claims. (Cl. 229-87.) A method is claimed for the wrapping of cakes of soap with an inner wrapper of greaseproof material.

2,621,124. Pulp purification. Louis S. Keyser and Robert E. Brown, assignors to Rayonier, Inc., Shelton, Wash. Filed May 29, 1946. 7 claims. (Cl. 92-13.) Pulp is washed with the spent liquor from a previous experiment, whereby the pulp is partly dewatered and the sodium hydroxide content of the liquor is recovered.

2,621,232. Apparatus for measuring moisture. John R. Spalding, assignor to E. I. du Pont de Nemours and Co., Wilmington, Del. Filed Feb. 8, 1951. 6 claims. (Cl. 175-183.) The moisture content is determined by measuring the electrical resistance at a plurality of locations.

2,621,233. Apparatus for measuring moisture in sheet material. John R. Spalding, assignor to E. I. du Pont de Nemours and Co., Wilmington, Del. Filed Feb. 8, 1951. 6 claims. (Cl. 175-183.) This is similar to the preceding patent.

December 16, 1952

2,621,422. Drying machine for fabric and paper webs. Philibert Deck, Zurich, Switzerland. Filed July 23, 1949. 2 claims. (Cl. 34-158.) The drying machine is provided with nozzles, the lengthwise axes of which lie parallel to the fabric web and may be swiveled on pivotal axes positioned perpendicularly to the latter.

2,621,567. Paper shredding machine. Filemon T. Lee, San Francisco, Calif. Filed May 23, 1949. 6 claims. (Cl. 93-1.) A machine is designed for shredding newspapers into strips to be used in packaging.

2,621,736. Slitting and winding apparatus. Thomas M. Scruggs and Earl K. Hall, assignors to Bemis Bro. Bag Co., St. Louis, Mo. Filed Oct. 21, 1948. 29 claims. (Cl. 164-65.) The machine is designed for slitting a web of paper into narrow strips and winding them into tight rolls without requiring the strips to be laterally spaced from one another.

2,621,757. Extensible and collapsible filter bag. Emil Anderson, assignor to Electrolux Corp., Old Greenwich, Conn. Filed Nov. 28, 1947. 1 claim. (Cl. 183-51.) A bag is designed for a suction cleaner.

2,621,783. Collapsible tray or carton. Kenneth T. Buttery, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed March 3, 1950. 2 claims. (Cl. 206-45.14.)

2,621,823. Method of labeling containers. Lloyd M. Perry, assignor to Nashua Corp., Nashua, N. H. Filed April 19, 1951. 2 claims. (Cl. 216-62.) A method of securing labels by means of heat-activated adhesives.

2,621,847. Ventilated container. Anthony J. Stefanich, Fresno, Calif. Filed April 26, 1948. 5 claims. (Cl. 229-6. The container is designed for fresh fruits, vegetables, and the like

2,622,007. Process for producing sulfur dioxide and sulfu burner. Luois N. Allen, Jr., assignor to Chemical Constructio Corp., New York, N. Y. Filed March 16, 1949. 3 claims (Cl. 23-179.) The sulphur burner is designed in plants wher three tons or less of sulphur are burned daily.

December 23, 1952

R23,597. Partitioned carton. Robert M. Bergstein, Wyoming, Ohio. Original No. 2,545,803, dated March 20, 1951 Application for reissue March 18, 1952. 21 claims. (Cl. 229-28. Four additional claims are covered.

2,622,276. Process for manufacturing composite board Winfred E. Wilson, Tacoma, Wash. Filed July 24, 1948. 3 claims. (Cl. 18-47.5.) A disposable collapsible paper containe holds the loose wood particles and binder; the assembly, withou previous prepressing, is placed directly in the board press Irregular marginal portions of the finished board are trimmed of along with the container side wall.

2,622,308. Cushioning material and method of making same Melvyn J. Harris, Nathan Einbinder, and Lee A. Manus, Chicago Ill. Filed July 19, 1951. 16 claims. (Cl. 28-79.) A resilien felt is prepared from a mixture of 30–60% of wood fibers (ground wood pulp sprayed with dextrin starch or previously felted woo fibers) and 40–70% of waste cotton.

2,622,313. Apparatus for applying an aqueous bituminou emulsion to a fibrous web. Chester R. MacDonald, assignor t The Patent and Licensing Corp., New York, N. Y. Filed Dec. 4 1948. 1 claim. (Cl. 29-114.) An applicator roll for water proofing paperboard with a bituminous emulsion is claimed it consists of a hollow cylinder with a number of internal duct which exert a pumping action on the emulsion in the underlyin trough when the cylinder revolves.

2,622,343. Papermaking machine. William K. Metcalfe assignor to J. O. Ross Engineering Corp., New York, N. Y Filed Feb. 9, 1950. 8 claims. (Cl. 34-122.) Improvements o the Yankee drier consist of an increased air flow impinged on th sheet at closer intervals than heretofore and recirculation an re-use of portions of the drying air.

2,622,490. Apparatus for treating wood pulp and the like James T. Coghill, assignor to Curlator Corp., Rochester, N. Y Filed Sept. 9, 1947. 12 claims. (Cl. 92-26.) This patent cover a machine (Curlator) for treating pulp according to the metho of Hill and Edwards as covered by U. S. patent 2,516,384 (July 25, 1950).

2,622,491. Process for making multiply waterproofed sheets Chester R. MacDonald, assignor to The Patent and Licensin Corp., New York, N. Y. Filed Oct. 4, 1948. 1 claim. (C 92-40.) A modified aqueous emulsion of asphalt containing mineral colloid (e.g., clay) treated with an acidic salt (alu sodium acid phosphate, and the like) or an acid (e.g., sulphur acid) to adjust the pH within a range of 3.5 to 5 is used in th preparation of multi-ply sheets.

2,622,492. Selective web transfer control for paper machiner John E. Goodwillie, assignor to Beloit Iron Works, Beloit Wis. Filed July 26, 1947. 6 claims. (Cl. 92-49.) A transfe roll of the ordinary suction type is selectively provided with ai at sub- and superatmospheric pressure; the latter prevents trans fer of the sheet to the pickup felt by the roll, whereas the forme assists in the transfer of the sheet.

2,622,493. Folding machine. Albert F. Shields, assignor t the S&S Corrugated Paper Machinery Co., Inc., Brooklyn N. Y. Filed May 7, 1949. 4 claims. (Cl. 93-49.) Improve ments over the machine covered by U. S. patent 2,583,712 (Jan. 29, 1952) are claimed which permit the delivery of crease blanks of an increased range of sheet sizes at an increased foldin rate.

2,622,558. Machine for coating web material. Adolph E Mikkelsen, assignor to Inland Wallpaper Co., Chicago, Ill Filed Jan. 19, 1948. 3 claims. (Cl. 118-249.) A coating ma chine of the fountain-roll type is claimed for the coating o web material prior to printing or applying colored designs Suction traction means are provided for drawing the coated ma terial past small-diameter, highly polished finishing and smoothi ing rolls, driven at a greater speed of travel than the web and i opposite direction to it. Means for coarse and fine adjust ments of the different units of the machine are provided.

2,622,777. Bottle carrier. Reynolds Guyer, assignor t Waldorf Paper Products Co., St. Paul, Minn. Filed Aug. 5 1948. 6 claims. (Cl. 224-48.) A generally rectangular shaped paperboard tray is provided with a wire frame secured b notches and tabs to limit the sliding of the wire.

2,622,784. Disposable carton mold box for frozen food con fections. West Hammond, Salt Lake City, Utah. Filed Aug 9, 1949. 8 claims. (Cl. 229-36.) A mold box of moisture proof paperboard has a slotted cover for the insertion of sticks i the confection. The mold can be peeled from the harden block without heating.

2,622,785. Container. Herbert M. Kieckhefer, assignor to Kieckhefer Container Co., Camden, N. J. Filed April 28, 1949. 6 claims. (Cl. 229-44.) The invention deals with metal-reinforced cover flaps of a returnable cardboard carrier for beverage bottles.

2,622,786. Siftproof automatic bag and method of making. William J. McDowell, assignor to Benj. C. Betner Co., Devon, Pa. Filed Feb. 8, 1949. 6 claims. (Cl. 229-55.) A conventional automatic-bottom bag formed from a two-ply gusseted tube is rendered siftproof by a heat-sealed inner ply and special bottom construction.

2,622,960. Glyoxal treatment of absorbent paper to improve wet strength. Walter E. Woods and Willard A. Schenck, assignors to A. P. W. Products Co., Inc., Albany, N. Y. Filed March 16, 1948. 10 claims. (Cl. 8-116.4.) An absorbent paper of high wet strength is prepared by depositing 0.3–3.0% of glyoxal on a preformed sheet and heating the sheet to at least 220°F. for 15–16 sec. to cause reaction of the glyoxal with the cellulose.

2,622,979. Modified synthetic resin and paper containing the same. Gerald I. Keim, assignor to Hercules Powder Co., Wilmington, Del. Filed Aug. 14, 1947. 10 claims. (Cl. 92-3.) A urea-formaldehyde resin is treated with sodium lignosulfonate, the pH is adjusted to about 5.5 with formic acid, the mixture is refluxed until it has the desired viscosity, and diluted with alcohol. The product is dark brown; when used with rosin size, it gives a high wet-strength paper.

2,623,040. Method of coagulating colloidal lignates in aqueous dispersions. John C. Keilen, Jr., Frank J. Ball, and Robert W. Gressang, assignors to West Virginia Pulp and Paper Co., New York, N. Y. Filed July 6, 1950. 6 claims. (Cl. 260-124.) Black liquor is carbonated and passed through a tubular zone in which it is heated at a temperature in excess of 170°F. and is maintained under pressure in excess of the vapor pressure corresponding to the temperature of heating. It is also subjected to agitation corresponding to a Reynolds number in the range of 700 to 1500. The particle size of the resulting sodium lignate depends on the degree of agitation.

December 30, 1952

2,623,239. Method and apparatus for feeding comminuted board-forming material for pressing. William J. Fischbein, assignor of one half to British Artificial Resin Co., London, England. Filed Nov. 18, 1949. 4 claims. (Cl. 18-5.) A machine is described for laying a mat of board-forming material (wood powder, sawdust, etc.) upon a continuously moving band for preliminary heat treatment by radio-frequency current before application of pressure.

2,623,441. Bagmaking apparatus. Alfred G. Rose and Joseph A. Gilbert, assignors to Rose Brothers (Gainsborough) Ltd., Gainsborough, England. Filed Jan 8, 1948. 5 claims. (Cl. 93-26.) An apparatus for forming tubes from a web of wrapping material, sealing the overlapping edges and bottoms, and severing the completed bags is claimed.

2,623,442. Box partition forming and inserting machine. James B. Thaxton, assignor to Paper Package Co., Indianapolis, Ind. Filed Oct. 21, 1949. 10 claims. (Cl. 93-37.) A machine for forming partitions and inserting them in boxes is claimed.

2,623,443. Manufacture of helically wound tubes. Ernest B. Robinson, Ashgate, Chesterfield, England. Filed Feb. 28, 1948. 9 claims. (Cl. 93-80.) The machinery for making the tubes described in U. S. patent 2,623,445 is claimed.

2,623,444. Method of making lined lapped seam fiber containers. Curtis E. Maier, Festus L. Minnear, and Halford E. Brockett, assignors to Continental Can Co., Inc., New York, N. Y. Filed April 8, 1946. 4 claims. (Cl. 93-94.) The liner is secured to the body web while in the flat so that it projects beyond the sides. The projecting lining is used in making the lapped seam.

2,623,445. Method of producing helically wound containers. Ernest B. Robinson, Ashgate, England. Filed Feb. 5, 1947. 7 claims. (Cl. 93-94.) A method for the production of helically wound tubing with circumferentially disposed unitary pattern is described, in which each pattern is intact and waste is minimized.

2,623,558. Machine for removing bark from logs. Axel E. Andersson, assignor to Söderhamns Verkstader Aktiebolag, Söderhamn, Sweden. Filed June 10, 1949. 6 claims. (Cl. 144-208.) A compressed-fluid-pressure (preferably compressed air) controlled barker for handling logs of different diameter and hardness (including crooked and knotted wood) includes bark-removing elements, peeler elements, and planing tools which remove the remaining bark and bast.

2,623,572. Apparatus for creping paper. Rudolf Haas, assignor to Zellstofffabrik Waldhof, Mannheim-Waldhof, Germany. Filed May 19, 1950. 9 claims. (Cl. 154-30.) An apparatus for creping paper in two directions is claimed.

2,623,680. Container and method of making same. Isaac L. Wilcox, assignor to Oswego Falls Corp., Fulton, N. Y. Filed Sept. 4, 1948. 3 claims. (Cl. 229-4.5.) The manufacture of a tubular paperboard container for liquids and the method of inserting and crimping the bottom-end closure are described; hot-melt and heat-resistant adhesives are used.

2,623,681. Container body and method of making same. Isaac L. Wilcox, assignor to Oswego Falls Corp., Fulton, N. Y. Filed Sept. 4, 1948. 4 claims. (Cl. 229-4.5.) A similar construction as in the preceding patent is claimed, in which sheets nonabsorbent to hot-melt adhesives are inserted between absorbent paperboard plies; all operations are performed on conventional machinery.

2,623,682. Shipping and display package. Earl B. Candell, assignor to General Electric Co., Schenectady, N. Y. Filed Dec. 28, 1949. 3 claims. (Cl. 229–19.) The container consists of a pull-out tray with rows of circular cuts for holding spherical articles, such as small flashlight lamps.

2,623,683. Partitioned carrier and method of making it. William A. Ringler, assignor to The Gardner Board and Carton Co., Middletown, Ohio. Filed Feb. 20, 1947. 2 claims. (Cl. 229–28.) The method for the manufacture of a one-piece, knockdown, partitioned paperboard bottle carrier is claimed.

2,623,684. Carton. Peter C. Collura, assignor to Container Corp. of America, Chicago, Ill. Filed Sept. 22, 1950. 1 claim. (Cl. 229–31.) A one-piece folding carton has interlocking detents and detent-receiving openings to hold the cover and tray portions against accidental opening.

2,623,685. Plastic cover for waxed paper containers. Donald W. Hill, assignor to Crown Cork Specialty Corp., Decatur, Ill. Filed Oct. 3, 1947. 1 claim. (Cl. 229–43.) A friction-sealed, replaceable cover of transparent polystyrene for polygonal waxed-paperboard containers used in food-freezing lockers is provided.

2,623,686. Two-way mailing device. Morton Covan, Hollywood, Calif. Filed April 16, 1951. 2 claims. (Cl. 229–73.) In addition to advertising, a matchbook carries a detachable postcard and is provided with a carbon paper section which can be used in the absence of a pen or pencil. The nonignitable end of a match can be employed as the writing instrument.

2,623,687. Combined greeting and gift bearing folder. James E. Williams, Boothwyn, Pa. Filed Jan. 7, 1949. 5 claims. (Cl. 229–87.) The construction of such a package, the main body of which is produced from paper, is described.

2,623,820. Treatment chambers for ligno-cellulose material and the like. Hjalmar S. Messing, New York, N. Y. Filed April 21, 1949. 5 claims. (Cl. 92–7.) In a modification of the Asplund system, one or more treatment chambers are introduced between the feeding means and the defibrating mechanism; this increases the capacity of the apparatus.

2,623,874. Cellulose-morpholinium derivative composition and process. Kenneth R. Brown, assignor to Atlas Powder Co., Wilmington, Del. Filed Jan. 16, 1950. 15 claims. (Cl. 260–212.) The addition of 10% aqueous N-methyl-N-lauryl morpholinium methosulphate to the wash water of refined chemical pulp for the viscose process or of 20% aqueous N-ethyl-N-cetyl morpholinium ethosulphate sprayed on a wet web of pulp will prevent incrustation of the spinning orifice.

2,623,875. Wood pulp and method of producing same. Paul H. Schlosser and Kenneth R. Gray, assignors to Rayonier, Inc., Shelton, Wash. Filed Sept. 9, 1950. 4 claims. (Cl. 260–212.) The treatment of refined wood pulp destined for manufacture of cellulose acetate, xanthate, etc., preferably before the initial drying, with a mixed ether containing polyethylene oxide radical and an aliphatic hydrocarbon radical of more than seven carbon atoms will result in an increased reactivity of the pulp fibers in the conversion processes and decrease the reaction time and the number of unreacted fibers.

Eighth
Engineering Conference
of the
Technical Association
of the
Pulp and Paper Industry

Sheraton-Mt. Royal Hotel
Montreal, Que.
Oct. 26–29, 1953

CORRUGATED CONTAINERS

Papers presented at the Corrugated Containers Sessions, 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 17–18, 1953

The Corrugated Containers Committee sponsored four sessions at the 38th Annual Meeting of the Association which were devoted to corrugated liner web printing, corrugated roll design and chrome plating, waste, and the glued lap box. The meeting was opened by Burt Mendlin, Cornell Paperboard Products, Inc., newly appointed chairman, succeeding F. D. Long, Container Corp. of America, who was largely responsible for the organization of the highly successful conference program of the Corrugated Containers Committee, W. W. Marteny of the National Container Corp. is the new secretary of the committee.

Corrugated Liner Web Printing

The first session was held Tuesday morning, Feb. 17, 1953, with D. P. McNelly, Fort Wayne Corrugated Paper Co., as moderator. The speakers and panel which discussed corrugated liner web printing were: L. M. Stempel, John Waldron Corp., L. O. Carlisle, A. E. Staley Mfg. Co; Joseph Gessner, E. I. du Pont de Nemours & Co., Inc.; H. C. Baker, Hudson Sharp Machine Co.; R. G. McCammon and L. K. Burnett, Ohio Boxboard Co.; G. N. Holme, Stone Container Corp.; and J. W. Viner, Interchemical Corp.

Equipment for Color Coating

L. M. STEMPEL

The Waldron Corp. has been allied with the paper converting industry throughout a period of 126 years, and the industry has graciously recognized our designs and manufacture of printing and other converting equipment during this period. Of course, during the earliest years, converting, as all of us recognize it now, was extremely limited in scope and certainly very limited in volume of production. The extensive vaults containing our records do not go back completely to the start of our converting experience, but we do have records of paper coating machines, to produce good printing surfaces, that date back to 1852 and it is not unusual to find some of our machines which are still in use and which were built as long ago as 1872. In these records we find that we built multicolor printers for fair production speeds as long ago as 1875, and that our records on machines adapted for aniline printing are practically synonymous with the advent of this type of printing in the production field.

Figure 1 is a typical multicolor printing press as first built for the wallpaper industry many, many years ago and we can point with pardonable pride to hundreds of these that are in current use today. Recently your speaker was advised of a line of 20 of these machines in a plant, the earliest of which bears the frame data of 1883 and which is still performing as effectively today as when first installed, in fact, more so due to accessories that have been provided as attachments to the original machines, new types of inks and better paper.

It is difficult to imagine a more simple setup or multicolor work than this printer. These have been built in sizes which accommodate few colors and in sizes which accommodate as many as 16 colors. I may comment that 16 colors on any machine are a man-sized problem for any printer or production man, nevertheless, under good conditions of drying and absorption, the daily production of this machine is astonishing.

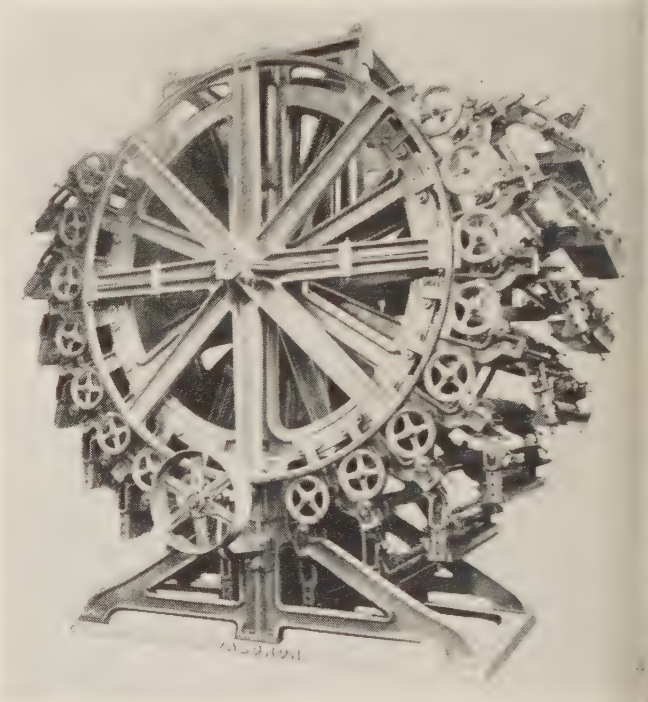


Fig. 1

Granted, however, it has its drawbacks in some respects, that adjustment for running register may be done only when the press is stopped, but such fact has not been as detrimental as we imagine, or the press would not continue in use. It is rather significant that in the past few years, we have been

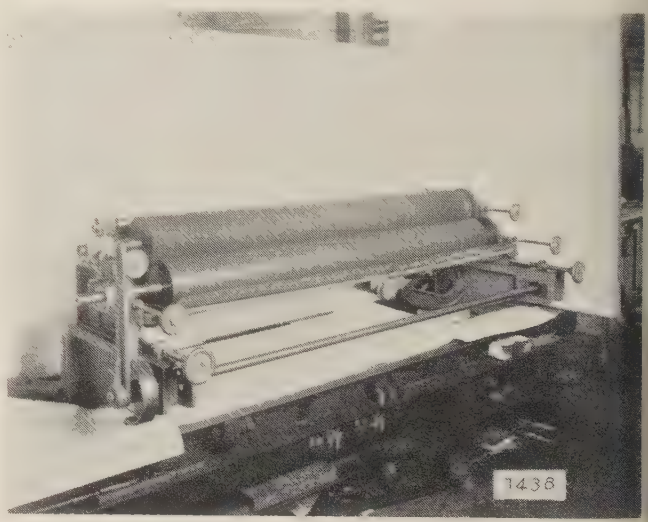


Fig. 2

L. M. Stempel, John Waldron Corp., New Brunswick, N. J.

required to supply the trade with 15 of these and they are still in demand in the second-hand market when one can be found that has been kept in good shape. The advantage of the use of a common drum for all printing nips and the simplicity of the register gear train for adjustment due to variable stock shrinkage and fit of pattern are features of this type of printing

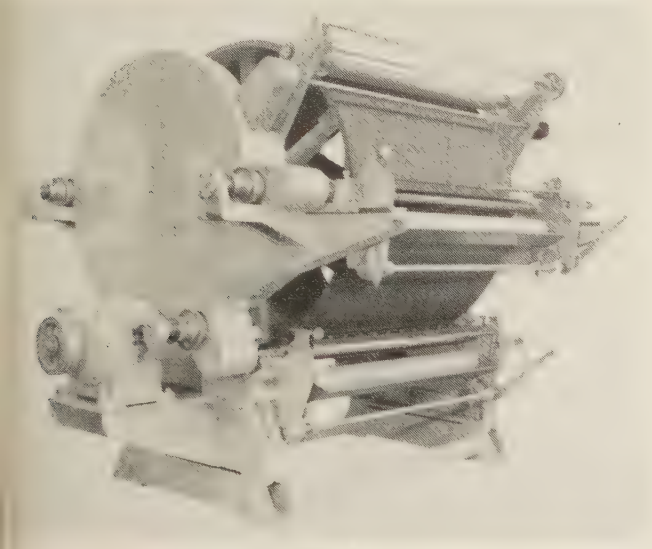


Fig. 3

machine. The single drum holds the web for all commercial clearances and most important of all is that this applies to webs of all character, whether paper, textile, or those which are dimensionally unstable such as vinyl and polyethylene film.

These printing machines have a peculiarly rigid type of frame construction and they have been built in web widths from 6 up to and including 60 in. and with repeats of 12 to 32 in. while the center drums have been built in sizes up to 12 ft. in diameter. To take the press off impression, up to and including 12 colors, the center cylinder is raised until the printing heads are disengaged and it returns to impression simply by lowering the center cylinder. Recent designs have embodied air-operated or hydraulic lifts for this purpose.

It has, likewise, been equipped in a great many instances with aniline heads which are illustrated in Fig. 2.

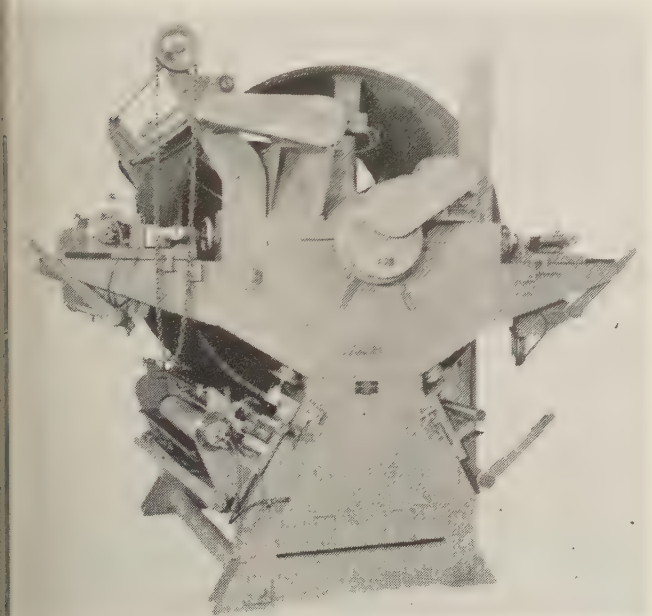


Fig. 4

Figure 3 is a further step in the evaluation of this popular style of press built, in this instance, for rotogravure and is one of about 30 of this type now operating. This obviously later design of machine is conveniently convertible to aniline print-

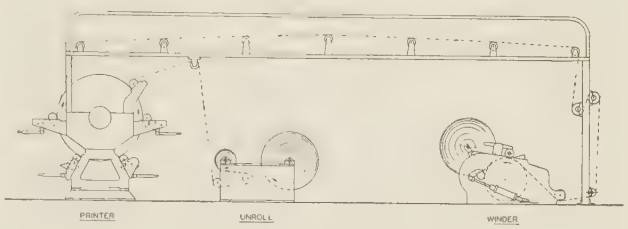


Fig. 5

ing in the same manner as previously described in connection with the earlier type. This later type was designed to answer the many requests for a superior machine, for utilizing the simplicity of the central drum feature but with the addition of simple register control while operating. Running register on this press is accomplished by handwheels through a spiral key advancing or retarding the printing cylinders individually. A variable stroke hydraulic cylinder moves the doctor blade on the rotogravure type across the face of the gravure roll in an axial direction with an ever-changing intermittent stroke so that no pattern is formed on the engraved roll. Again this type of press runs paper or dimensionally unstable materials such as vinyl film, textiles, etc.

In this design, instead of raising and lowering the center drum for off or on impression, the printing heads are power moved in and out of printing position by push-button control as shown in Fig. 4.

Figure 5 shows this machine coupled with a semiautomatic unwind and a full automatic re-roll stand. In a setup like this, the printer is working continuously without shutdown for changing rolls, the splices being made at production speed.

The next three figures indicate in the respective order as they

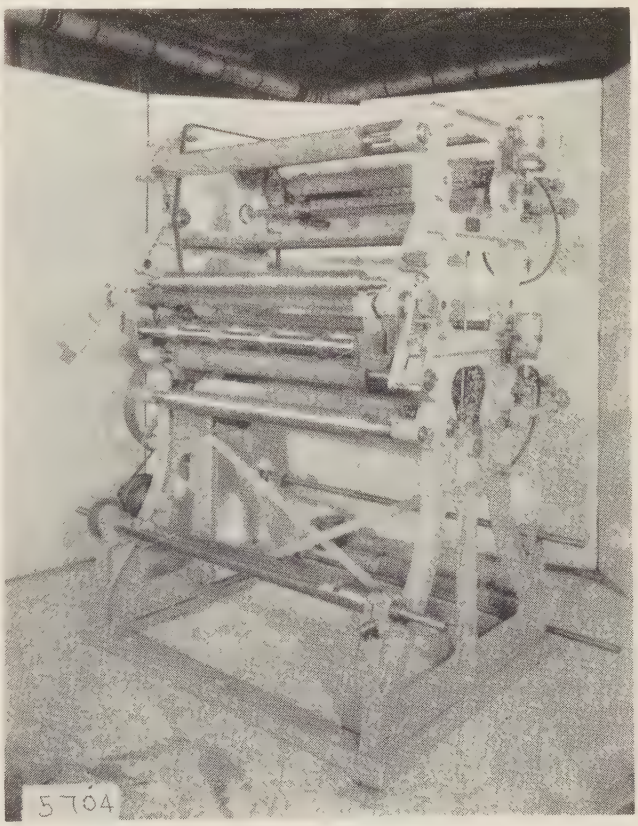


Fig. 6

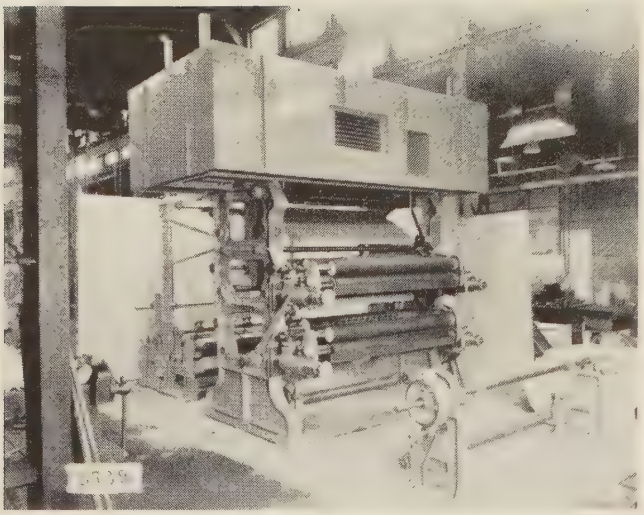


Fig. 7

are shown, a light, a medium, and a heavy duty aniline printer. Figure 6 is a conventional aniline press in which simplicity and very moderate price are the features. Many of these are in constant daily use with down time for repairs at the very minimum and consequently they afford an excellent return to the printer for a very moderate cost investment. Figure 7 is a similar type with drying oven between colors but in this case of wider width. Figure 8 is a heavy duty aniline press with the guards removed to show the manner of driving the heads which in the case of these three types, is by multiple width roller chain. It might be supposed, and we have heard it expressed, that the manner of this chain drive is a feature that would require considerable upkeep; unexpectedly, in presses of this type, even in the heavier duty style, maintenance is very moderate. This chain represents without enclosure a useful life of 10 years in daily production and is simple and relatively inexpensive to replace; with semi-enclosures and oil mist lubrication, the life is doubled so that it presents no problem whatsoever. Operators of these presses find them particularly easy to handle, adjustments for register are readily made while running.

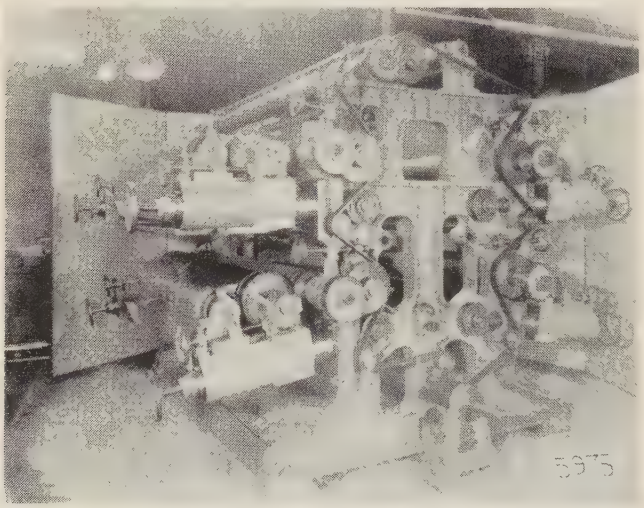
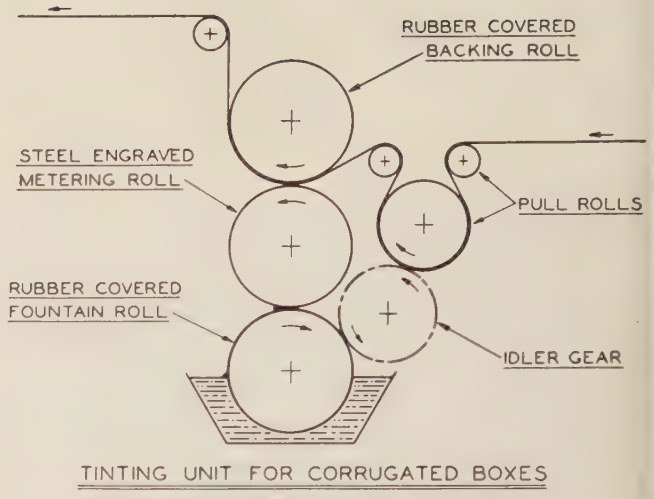


Fig. 8

Probably one of the more interesting features of modern flexographic or aniline printing is its increasing adaptation to "on the machine" production.

The accuracy of modern rubber plates, the availability of



TINTING UNIT FOR CORRUGATED BOXES

Fig. 9

machines of the necessary web width, the uniformity and controllability of modern inks all help to speed up the production and reduce the cost of product inherent in multiple printing operations.

Figure 9 is a diagram of an aniline tinting unit designed to be a part of a paper converting machine. The unit puts a single color on the outside of corrugated boxboard. You will note that the paper is pulled through the tinting unit. The pull of the paper through a gumming machine, for instance, drives the tinting unit and in this manner a tinting unit such as is shown may be readily installed on present equipment without any special drive, unwind, rewind, or separately operating feature. Such tinting units are built in widths up to 130 in. or more.

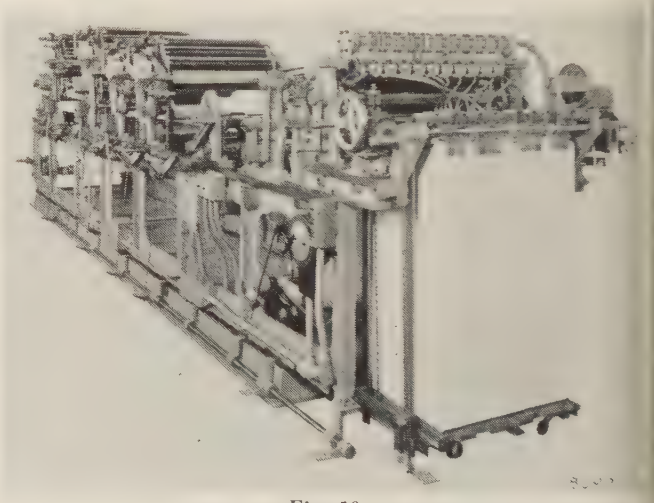


Fig. 10

Just in closing, we are glad to be able to show you Fig. 10 which is a four-color litho-offset press printing either one or both sides of a web of paper from the roll and which may be rewound or sheeted at the unusual speed of up to 25,000 sheets per hr., the sheet size being $17^1/_2$ by $22^1/_2$.

Color Coating

L. O. CARLISLE

WE HAVE all enjoyed the papers presented at the national meetings of TAPPI, as well as those presented at the several divisions throughout the country. On occasion the

L. O. CARLISLE, A. E. Staley Mfg. Co., Decatur, Ill.

finition and qualification of terms have required a considerable portion of the time allotted, and so we may rapidly dispose of this formality, let us accept the dictionary definition as, "coating, a film applied to any surface," and to this film we propose to add color and put it on a sheet of linerboard.

Beater application as well as calender staining are very well known to the industry, being the accepted practice to obtain colored liner. The necessity of making such large runs on the paper machine, the up and down quantities (that pulp which has been colored in arriving at the desired shade, and in going back to regular grade, that which has been mixed with uncreated stock) and the necessity of trimming the mill, makes this undesirable in obtaining colored board for most box orders.

The printing presses were used early in this venture to entirely cover a sheet, but this was an expensive method. Today we have some over-all printing of fabricated board, and the corrugations, any degree of "washboarding," imperfections in the liner, and register on the sheet, add to the difficulty of getting a good over-all pattern. Difficulty also is found when it is necessary to print over the colored liner in that the ink will pick off on the second pass through the press. Generally this method is used as a "must" to produce what the customer wants.

To state the problem properly, it is desirable to be able to supply a colored liner to the corrugator, or laminator, which has been made in a small enough quantity to be practical in fabricating the boxes for any reasonably sized order. Versatility in solving this problem in the industry has only been exceeded by the desire to go further. It has been our pleasure to observe many of these operations, and the general conclusion is that you are all arriving at colored liners by almost as many methods as there are plants coloring. Time would not permit a lengthy discussion of methods, but let us consider some of the more commonly observed machines.

Some coatings, and again we must go back to a definition, "any film," are applied as the board is fabricated. This is a staining operation immediately ahead of the doublebacker, and is made possible by the use of a readily evaporated vehicle, such as alcohol. The dyestuff is either water or alcohol soluble and is diluted to the desired concentration, applied to the liner by a rubber pickup roll, and dried much as a clothes wringer in the initial application. As it goes around the preheater it is further dried and the volatile vehicle leaves the board dry enough to fabricate. In this you are limited to only those dyes which will give a definite shade and cannot be "brightened" by pigment or clay. We have all seen examples of this in certain "tans" used on some of the larger nationally distributed boxes. Some of the undesirable features here are: a slowing down of the machine, addition of another operation to an already complicated machine, waste is increased at one more location, and "crock" or bleed cannot be stopped in this application, and we must accept a box that will stain when moistened. Operators of machinery in the finishing room generally wind up the same color as the board you are running.

The color coating of linerboard is more universally done on a separate machine consisting of mill roll stands, some with preheaters, and application station, a drying roll or an oven, and a rewinder. That sounds like a simple operation, unwind the roll, apply the film, dry it, and rewind it.

How you dry the paper after the coating is determined by the coating you apply, but dry it you must. No actual heat or oven drying is necessary it the staining is accomplished ahead of the corrugator. How you apply it is where the most varied of methods is employed. We will deal with the application of coatings by four methods commonly observed and attempt to evaluate each:

1. Intaglio roll, or commonly called an "etched roll." Picture if you will a roll to which have been fastened common thimbles as used by your grandmother. These are placed as close together as possible around the surface of the roll and as the roll turns and comes in contact with the paper, the thimble full of coating is applied to the paper or dumped on the paper. The depth of the thimble will determine the amount applied, and varies from just a few thousandths up to as high as twenty thousandths.

2. The pattern roll will best be described as a glorified intaglio roll in that in the engraving process, and this is sometimes called a design roll, a portion of the roll is filled with thimbles of different depths, thus applying more in one place than another and the difference in coating will leave the desired printing in the sheet. In some instances a solid portion of the roll is left, and this will take either a very light coating, or none at all, and will give the appearance of a difference in shade, or leave the natural color of the paper.

3. The solid rubber roll is employed in application of color and is readily adaptable to almost any kind of a basic coating one wishes to apply. The amount of clearance between the pickup roll and the rubber roll determines the amount of coating applied. The "aniline machines," so named because they were intended to apply aniline colors, were adapted to most coating applications, and they are standard equipment with rubber rolls.

4. Metering rolls, are from solid rolls, to the finest possible wire to wind on a round rod. The size of the wire used determines the amount of coating applied in that as the wire is wound close together there is a V left between the wires. These rolls are turned, generally in opposite direction to paper travel, and the predetermined number of wraps per inch determines the coating that will get through the V and stay on the sheet. The accepted method of application is flooding and doctoring off the excess with the metering roll. This roll is generally driven independently, and the speed at which it is driven will increase lengthwise markings or streaks. While we have made application with all these methods, more of our work has been with the metering roll.

Results from the methods described are more determined by the base of the coating than by the method of application. The base of the coatings varies as much as the methods of application. Most frequently found in use are:

1. Ink, as we know it, is generally extended with varnish, drier, and a volatile liquid, again alcohol of methanol. Without exception this does a good job. We will come to some of the objectionable features of some typical coatings, but we can generally accept this as nearly foolproof. No doubt this accounts for generally increased cost per thousand square feet.

2. Casein base is extended with varnish and alcohol with one of the aldehyde group as a hardener. In a group with this we should include soy protein being used in almost direct substitution for casein. Both these products, being highly insoluble when set, generally add to the "crock" test but when a water-soluble dye is used; they have some bleed.

3. Starch base, generally an oxidized starch used in conjunction with urea-formaldehyde resins, or glyoxal, is made

L. M. Stempel, John Waldron Corp.

L. O. Carlisle, A. E. Staley Mfg. Co.

insoluble in water much as the waterproof adhesives were for the V boards.

Most likely your "secret process" has not been mentioned, and you will be most grateful, but "why" the different methods and the different bases? I have prefaced this with a general statement that, and I repeat, in general the base of the coating determines the result more than the method of application. The ink we dismiss with a statement that it is satisfactory in any application, properly dried, and is not more universally used due to expense. The casein, soy protein, and starch-base coatings can be grouped for our discussion. The viscosity, amount of highly volatile vehicle, and the cohesive characteristics determine the pattern or appearance of the coating. These three give what we call a more pronounced "ripple," and when color has been added to the coating, it becomes more pronounced. That was one of the problems we encountered early. When applied by any method, these three will give a more pronounced ripple, as will ink which is so finely rippled that it is difficult to detect, and therefore not objectionable. The thinner or less viscous the casein, soy protein, or starch, when applied by either the intaglio roll or the rubber roll, the larger the ripple. What was an undesirable feature in one coating was to become a distinguishing coating for one supplier as the coloring of liner became more common. Early, we approached a very large distributor of colored liner to tell of our problem on ripple, and our inability to get it on smooth, and his reply was, "Where were you last week? I just placed an order for a ripple roll because we can't ripple our coating."

Many of you are presently coloring liner in some manner. Others are listening and anticipating, and it is only fair here for you to know that this coloring operation is used as a business barometer. When the color inquiries start, we know that natural board business has declined, and vice versa, and it is to those anticipating that a summary of these remarks could be made by saying, you can color coat with any type machine, with any type coating, and get a predetermined result. The machinery part of this program is the least difficult for those reasons.

If you anticipate coloring, sample the various colored liner presently being distributed and sit down with someone and tell them, here is what I would like to make, but be sure you consider the difficulties before you accept it.

Color Coating Container Board

JOSEPH GESSNER

THE perfection attained in the design and construction of corrugated containers has expanded their use into many new fields. It was formerly considered impractical to package varied types of merchandise in paper containers, but today, corrugated boxes are physically capable of protecting and shipping almost any type of product. The construction features have received considerable attention and have been exploited to the fullest advantage by the industry.

Conversely, the appearance of the corrugated container has received far less attention and little has been done to improve it except for certain specific uses. As everyone knows, a good appearance will attract attention. The natural shade of unbleached kraft is very satisfactory for many uses, but color greatly improves the surface appearance of the container. The correct combination of over-all coloring and printing will attract attention from considerable distances. The use of color for enhancing container appearance also provides other valuable advantages, chiefly the following:

1. Low-cost advertising through instant identification of product and manufacturer.
2. Easy storage identification which is important in warehouses. Usually results in labor saving and rapid handling.
3. Home storage provides long-term advertising value. This type of advertising could result in reorders for gift purposes.
4. Attractive low-cost displays for retail use.

JOSEPH GESSNER, Paper Div., Technical Lab., Dyes and Chemicals Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

There are several methods for coloring the kraft paper for production of kraft liners that are used for the outside construction of the corrugated container. Briefly, the pulp can be colored and formed into kraft liner in the usual manner. The pulp can be dyed by metering a color solution to the pulp system just ahead of the fan pump. The color solution can also be added continuously to the machine chest or to the headbox. The kraft liner can be surface colored or stained by applying a water solution of the color at the size press or at the calender. The acid and basic dyes are generally used for surface coloring.

The outstanding dyes for surface coloring kraft liner are:

Acid Dyes:		
Yellows	Tartrazine conc.	(C.I. no. 640)
	Metanil Yellow conc.	(C.I. no. 138)
Orange	Orange II conc.	(C.I. no. 151)
Red	Crocein Scarlet N Extra	(C.I. no. 252)
Green	Green NV Extra	(C.I. no. 735)
Blue	Fast Blue R	(C.I. no. 208)
Violet	Violet C4BN	(C.I. no. 698)
Black	Blue Black SX	(C.I. no. 246)
Tans and browns are made from a mixture of: Orange II conc. or Crocein Scarlet N Extra, Metanil Yellow, Blue Black SX		
Basic Dyes:		
Yellow	Auramine conc.	(C.I. no. 655)
Brown	Basic Brown BR	(C.I. no. 332)
Reds	Safranine T Ex. conc. 125%	(C.I. no. 841)
	Rhodamine 5GDN Extra	(C.I. no. 752)
	Rhodamine B Extra	(C.I. no. 749)
Green	Victoria Green S.C.	(C.I. no. 657)
Blues	Methylene Blue ZX	(C.I. no. 922)
	Victoria Pure Blue BO	(Pr. 198)
Violet	Methyl Violet S conc.	(C.I. no. 680)

We have made only a few comments regarding other methods of coloring kraft paper because most of our discussion will be confined to the color coating of container board as part of the converting operation. Recent improvements in the color coating of container board are not too well known, and these will be discussed so that you may have a better understanding of the developments that have taken place. By color coating with a mixture of starch, water, color, and a urea-formaldehyde resin, it is possible to obtain an attractively colored container that is relatively low in cost and possesses very good wet rubbing resistance. The incorporation of white pigments, such as clay and titanium dioxide, produces pastel shades and other bright shades which cannot possibly be made by dyeing the pulp or by surface staining the kraft liner. Titanium dioxide imparts a very high degree of opacity and the water-dispersible type can be easily incorporated into the starch solution.

The proper selection of colors is especially important. Excellent wet rubbing fastness can be obtained by first applying the coating mix containing the color and then applying a clear coat of the starch-resin-water mix. This clear coat imparts a moderate degree of finish and provides very good water resistance. The color coat and the clear coat can be easily applied in a single operation by placing a drying cylinder between the two applicators. It is possible to obtain a color-coated surface that is free of lines or streaks by applying a low viscosity or water-thin color-starch mix. Although we recommend applying a clear coating over the color coat to produce very good water resistance, it is possible to produce many satisfactory shades without applying the clear protective coating.

Since the paper presented by L. O. Carlisle of the A. E.

Staley Co. describes the mechanical equipment and general type of coating mix, our comments are being confined almost entirely to the use of color.

The materials cost for coloring 1000 sq. ft. of container board will cover a range of 15 cents to 1 dollar. The cost figures vary appreciably depending on the type and quantity of color used and the type and quantity of white pigment needed to impart opacity. Many shades possessing moderate light fastness and good wet rubbing fastness can be made at a cost of 15 to 30 cents per 1000 sq. ft.

The basic dyes are generally the most economical colors to use, being tinctorially strong, extremely bright but relatively fugitive to light. They exhibit better light fastness when they are applied by this coating process than when applied to the pulp. Many of the colored containers are used only as single unit packages and will not necessarily require good light fastness. Basic dyes can be used to advantage and, in general, the wet rubbing fastness will be very satisfactory, even without the clear protective coating.

The acid dyes, as a class, possess excellent solubility in water. They rank next to basic dyes in brilliance and possess better light fastness. However, the acid dyes will bleed or rub off when the container becomes wet because these colors cannot be insolubilized with the urea-formaldehyde resin used in this process. In some instances, the acid dyes could be used for producing bright shades possessing good light fastness, but it would be necessary to apply a clear coating of starch resin to improve the wet rubbing fastness.

The direct dyes are duller than either the acid or basic types. They can, however, be insolubilized reasonably well, and the light fastness is generally adequate for most uses.

The pigment colors produce coatings that possess very good light and wet rubbing fastness. Since these colors are insoluble in water they naturally exhibit very good wet rubbing resistance. The dispersed pigments, which are required for use in coating mixes, can be easily incorporated in the starch coating mix. The basic or direct dyes can be used in combination with the pigment colors to lower the cost without substantially reducing the light fastness or wet rubbing resistance.

The coverage obtained from the coating mix will depend on the type and finish of the kraft liner and the solids content of the coating. A 100-lb. batch will usually cover from 15,000 to 20,000 sq. ft. of kraft liner.

When basic dyes are used in the coating mix they will show some fading when exposed for 2 to 4 hr. in strong sunlight. The pigment colors, which possess the best light fastness, may show some fading after 25 hr. exposure, but for practical purposes they can be considered essentially permanent to light. The direct dyes and acid dyes will generally show some fading in about 8 hr. A high degree of light fastness is undesirable in a carton to be used for display purposes. However, many satisfactory shades can be made with the water-soluble dyes.

WET RUBBING RESISTANCE

Wet rubbing resistance is sometimes more important than light fastness. Since the basic dyes are easily insolubilized in the starch-resin mix they are satisfactory for wet rubbing resistance. The direct dyes can also be insolubilized and are almost as resistant to wet rubbing as the basic dyes. Acid dyes will bleed or show relatively poor wet rubbing fastness unless a clear protective coat is applied.

It is possible to obtain shades that are very fast to wet rubbing by using the water-dispersible pigment colors. It is important to use the correct amount of catalyst, which is usually alum, and sufficient resin to obtain maximum wet rubbing resistance.

The degree of wet rubbing resistance can be easily determined by means of the Crockmeter. This is the official apparatus of the American Association of Textile Chemists and Colorists. This device provides a reciprocating rubbing motion simulating the action of a human finger and forearm. Actually, a spindle or peg is covered with a small piece of wet white cloth and this covered spindle rubs the surface of the sample being tested. The pressure is constant and the number of strokes may be varied. Usually five strokes are sufficient for determining relative rubbing resistance.

Preparation of Coating Mix:

The 25% starch solution
- 100 lb. starch (thin boiling type)
- 25 lb. urea-formaldehyde resin (as 100% active ingredient)
- 200 lb. water
- Slurry together using a suitable agitator
- Heat with steam to 190°F. and hold at this temperature for 15 min.
- Dilute with cold water to 400 lb. total weight
- Cool to 120°F. before using

The clay mix
- 100 lb. predispersed clay
- 50 lb. water
- Slurry together using an agitator. Other types of clay are satisfactory. The predispersed clays have the advantage in that they do not need the addition of a phosphate-type dispersing assistant

The titanium dioxide mix
- 50 lb. titanium dioxide (water-dispersible grade)
- 50 lb. water
- 1 oz. sodium hexa meta phosphate or tetra sodium pyrophosphate

These mixes may then be blended as desired with normal agitation. The water-soluble dyes should be dissolved in water heated to approximately 160°F. prior to addition to the coating mixture. The pigment colors should be dispersed in water prior to mixing with other ingredients. The water shown in the coating formulas may be used for dissolving or dispersing the colors. The alum solution should be added after all other ingredients are thoroughly blended.

CLEAR STARCH COATING MIX

This clear coating consists of a starch-resin solution without filler. It may be colored and applied as a low-cost coating, or it may be used as a transparent coating over a colored base. In the latter case it will increase the apparent depth of the shade, impart gloss, and provide a protective film. This protective coating will improve the wet rubbing resistance of dyes and help bind the pigments which are applied as the base coat.

Typical coating formulas for producing red shades are as follows:

One-coat application using a basic dye

65.0 lb.	25% starch solution
12.0 lb.	predispersed clay (67%)
0.5 lb.	Safranine T Ex. conc. 125%
20.5 lb.	water
2.0 lb.	50% alum solution
100.0 lb.	total weight

Two-coat application using a pigment color

Color coating formula

25.00 lb.	25% starch solution
25.00 lb.	water-dispersible titanium dioxide (50% slurry)
5.00 lb.	Lithosol* Red CSP paste
43.75 lb.	water
1.25 lb.	50% alum solution
100.00 lb.	total weight

Clear coating formula

65.00 lb.	25% starch solution
33.00 lb.	water
2.00 lb.	50% alum solution
100.00 lb.	total weight

The use of color in coating formulations, which are in turn applied as part of the converting operation, is actually much simpler than applying color on the paper machine. A number of shades can be produced in a single day by means of the color-starch coating process without interfering with or slowing down the production.

We wish to emphasize that almost any desired degree of light fastness or wet rubbing fastness can be obtained by the proper selection of colors. The actual requirements will depend upon the end use. If the container is used as part of a display in a store or store window, light fastness will be of prime importance. Wet rubbing fastness is usually important in all types of colored containers. In developing suitable formulations, primary consideration must be given to light fastness, wet rubbing fastness, and economy.

The color coating of container board is relatively small in volume as compared with the enormous production of kraft corrugated containers. The use of color offers unlimited possibilities for improving the appearance of the corrugated shipping containers and other containers. The color coating process is a means of producing many attractive shades at low cost. It is hoped that the facts presented will assist and encourage the further development and use of colored containers.

* Lithosol is a registered trade-mark of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Coloring Machines for Boxboard

HORACE C. BAKER

In this paper I am going to reminisce somewhat and go back to the time when the paper shipping box appeared on the market. If I remember rightly, the first of the paper boxes for shipping purposes was of the fiber type and the corrugated came later. I remember, too, the efforts on the part of the old wooden boxes to keep the paper boxes out of their field.

I had at that time just finished school and was a city editor of a small daily newspaper up in the lumber territory.

An official of the wooden box organization came to me and offered me a job which would be preparation of publicity to belittle the paper box and to bring out the merits of the wooden box. The salary offered me was very much greater than a poor newspaper man could hope to obtain, but before I came to a decision I went to an old friend of mine who made wooden boxes and asked him what he thought of the job.

He said, "I would not take the job if I were you because you can't stop progress. I'm an old man in this business and I know the paper boxes are going some place and you or all of the wooden box industry can't stop progress."

The early box machinery was crude, and manual operations were adapted to produce a box. Mills were offering boards natural colored and their product would hardly be accepted by any user of the present type of box.

Crude slotters and cutters were built by handymen in the box plants and corrugated board had not as yet entered the picture. Wooden box makers were spending a lot of money in their effort to squelch the new product.

However, in spite of competitors, poor tools, and lack of trade organization, the present paper box found its place and today the industry is organized. It has eliminated most of the handwork and the plants have special box designers that will create a container which will meet special shipping hazards and the demands that the box add advertising values as well as products safety.

Horace C. Baker, Hudson Sharp Machine Co., Green Bay, Wis.

For a good many years after that time, paper boxes were sold just as Henry Ford has sold his automobiles. "He would give the customer a Ford automobile with any color they desired, but it would have to be black." At that time the paper boxes had the natural color and nothing was done for a number of years before color went into the shipping boxes.

If my memory is correct, the colored boxes that were first in use carried a kind of a faded red. The linerboard was colored at the mill either at the beater or in the calender stack. This meant that the box manufacturer would order his paper precolored and he would then build up his box, leaving an overrun in the warehouse and eventually the warehouse had a large collection of "dogs and cats of colored boards" which to a certain degree wiped out all of the profit on the run.

The dye used in the mill for coloring the board faded in the sunlight and it was quite a few years later that arrangements were made for colors that were fast.

About this time the early aniline printing presses were brought into this country from Germany and some of the machines were taken over and built in this country. The ink definitely was aniline ink. The colors were not fast and faded out in daylight and it was quite a few years later that a better type of ink was provided by the manufacturers.

The aniline press for printing various types of wrappers and other products was brought to this country from Germany and we used it entirely for the printing of paper bags, wrappers, and similar products and my company had picked up one of these German machines to be used as a trial unit.

Eventually we took an order for a tinting machine which was 60 in. in width with one color only. The unit was used for straight aniline inks and as I previously stated, the ink was not fast.

We put out quite a number of these machines, none of them running more than 60 in. in width, until the box industry generally became interested in colored boxes.

They wanted a wider machine, they wanted a better ink, and they wanted direct decorative designs and pictorial designs.

Some efforts were made to prepare a small single color unit to place in line with the corrugated machine so that the sheet would be colored during the fabricating of the corrugated sheet. This, however, did not work out satisfactorily due to the fact that there were certain stops required in handling the press and it interfered with the continuous operation. I do not think at the present time that there is any use of a coloring machine in line with a corrugated machine with any satisfactory results.

Ink manufacturers became interested in providing real fast inks. Instead of just providing aniline colors, with more or less combinations of alcohols and other liquids, they turned to the manufacture of colors which were fast and in every way as good as standard oil inks. The colors were ground just as the colors were ground for standard inks and this gave the box manufacturer an ink that would give decorative color without any fading and provided a solid color.

Nothing was done for design work although there was definitely a demand on the part of box makers to provide multicolors as well as design. This brought rotogravure into the picture.

It also called for a machine that would provide multicolor designs and production with high speeds. This called for heavier equipment and more accuracy in machine construction. At the same time the plate makers provided more accurate rubber plates, as well as all types of design work for the aniline section.

The combination of machine, inks, and paste has enabled us to provide a standard machine. It carries two unwind stands, a rotogravure section with a 48 or 60-in. drier, a rotogravure section with an additional drier, and a double drum rewinder. A drive carried horizontally with spur gears drives the complete unit and each section may be thrown out

in at the will of the operator. The machine is flexible and we may, if desired, add a laminating section and a section for coating boards with a sulphur coating used for fruit shipping.

A laminating unit will mean just an additional section for applying paste or glue and a squeeze roll section for the lamination. This unit may also be used for sulphur coating. This would provide additional use of the machine and spread the investment through the additional production.

Today rotogravure sections can be made and installed with existing aniline machines. This will provide over-all coating or coloring with a low cost ink and provide a base color for the rotogravure process.

Prior to the War quite a number of these machines were constructed whereby the web would be first coated or tinted with an ink that would act somewhat as a filler. This web would be dried or at least practically dried and then would continue into the rotogravure section where it would be overprinted with the desired design, dried again, and rewound.

During the late War there was little coloring of board or production of board specialties but the coloring machines were in many instances used for treating linerboards for waterproofing and coating. When the War ended the demand for coloring and printing machines came to us in volume to a point where we used our previous experience to improve the machine and we at this time are working on several units, one of them running to a width of 90 in.

The sheet can be handled with four different types of coloring. It will take the linerboard and color it with an aniline color and dry and rewind. We can also by-pass the aniline unit and color the sheet with a rotogravure design and dry it and rewind. We can take the sheet and treat it with the aniline unit and carry it to the rotogravure unit for a multicolor job and dry and rewind. We can also run the sheet through the rotogravure unit, dry it, bring it back to the aniline unit, and we can print any design or lettering in aniline over the rotogravure base.

We have learned that a machine that will handle a 90-in. web of linerboard with a more-or-less rough surface, can be solidly colored and printed with this machine.

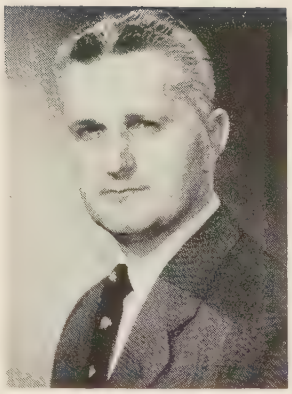
Our experience of over 20 years proves that there are certain factors that must be considered in a unit of this type. In the first place, we know positively that it is not a satisfactory unit which can be added to a corrugating machine for coloring and decorating the board.

We have also learned that the machine going into the plant of a box maker must justify itself to cover the investment that is made in the machine. It is quite evident that it is important to build into the machine various processes that will provide a maximum operating time each week.

We, therefore, have designed a machine with each unit a separate unit, that is assembled with a satisfactory drive. This means that in the future the purchaser of a printer tinter may spread his machine to permit the installation of a laminating unit. This means that he may merely use the machine as a laminator, it may be used to color his sheet and laminate it to the second sheet drying same and rewind it; or it may be used for treating the interlining sheet with sulphur or other coatings which may be desired for the inside of the sheet.

Building the machines or units in a single line makes it possible to get any combination of threading or process. It permits easy handling of the sheet and at the same time keeps the sheet intact during its movement from the parent roll to the rewound roll.

For the small manufacturer with a limited amount of capital to invest, we have provided a combination aniline roto machine with a single drier and rewinder. This machine permits the process of paper with the aniline process either with the over-all coloring or tinting or printing with rubber plates or rubber design rollers. The unit is so constructed



Joseph Gessner, E. I. du Pont de Nemours & Co.

H. C. Baker, Hudson Sharpe Machine Co.

that the aniline rollers may be removed and rotogravure cylinders installed in its place and the rotogravure process may be accomplished. This, of course, cannot be used to do both of these jobs at the same time. If you want to you can overprint or coat your paper first and then change your machine to the rotogravure method and re-run your paper overprinting it with roto. Because of the unit design, if the manufacturer has sufficient volume, they can coat and print in the same operation by adding extra units.

The cost of the units that are carried in the printer tinter depends entirely on the size and the number of the units purchased. An 80-in. wide, single-color or combination aniline roto unit with one drier would carry a price of approximately $30,000 or it may run to $75,000 depending, or course, on the width or the number of units.

The speed at which these machines operate depends on the kind and type of the product and the means provided for drying. For all general purposes, speeds of between 300 and 500 f.p.m., can be accomplished using high-pressure driers 48 in. in diameter.

One of the later innovations in this type of printing is the roto-offset. Roto-offset is generally accomplished by first coating the sheet with the aniline process in the regular manner, drying it, and then running through a rotogravure unit wherein is provided a rubber roll used as an offset roll.

In operation the engraved roll applies the ink to the rubber roll or rubber blanket roll, as it is called. The sheet passes between the rubber blanket and a steel impression roll thus taking the ink from the rubber roll and applying it to the web.

This has the advantage of bringing out more accurate detail of the engraving because a rough sheet requires an extreme amount of pressure to bring it in contact with the engraving roll to draw all of the ink out of the impressions accurately, whereas, the rubber roll being smooth and accurate does this very neatly and then applies it to the surface of the web.

Since this process used in the boxboard industry is comparatively new, we haven't as yet established all the definite data that we would like, but it can be said that some of the most beautiful printing in the rotogravure process on rough linerboard has been accomplished by this method.

The cost of applying these inks, tinting and printing, coating, varnishing, and so on varies a great deal. The cost of the ink itself depends upon the quality of the ink required to produce certain results. The absorbancy of the web itself and the amount of coverage required entails on the cost of the finished products.

The ink companies have done a lot of work in developing inks that produce high-quality work at reduced cost and more recent developments in ink using water as a solvent or a base and still having the inks fast to light and bleeding have again greatly reduced the costs.

Problems in Coloring and Decorating Liner Board

R. G. McCAMMON and L. K. BURNETT

Our experience at Ohio Boxboard is based on about 4 years' operation of one of the commercial coloring machines you have heard described, and some years before that on a home-made unit. Our present machine has so-called aniline or flexographic and gravure stations. We use the same basic ink formulations, of a protein type which we mix ourselves, on the two sections, and print solid color with a solid rubber roll on the first section and either a second solid color or designs from a gravure roll on the second section.

As in any printing the base on which the printing is to be done is most important. The first requirement for uniformity of coloring within a run and between runs is to have a uniform board color. This, of course, is most important with lighter shades and dye-type inks. We have found that we must standardize on a given color for the base sheet in order to make our program successful.

The base sheet must also be free from any dirt specks since these will show through many of the inks used for coloring. It also must be free of any materials, such as wax and asphalt, which tend to bleed through and cause a dirty appearance when heat is applied to the web to dry the ink.

The board to be colored must have a reasonably smooth finish since we are applying a relatively thin coating of color and any irregularities in the surface will show through this thin application of color and give a nonuniform appearance.

The surface of the board to be colored must accept the color uniformly and must not be too absorbent. If the board absorbs too much color the ink fails to have the hiding effect which it does when it stays on the surface, and the sheet becomes more difficult to dry with a resultant loss of production. We feel that a good water finish is necessary on either jute or kraft.

Having secured a satisfactory base sheet on which we intend to print, we then have the problem of securing satisfactory ink with which to do the printing.

Our principal difficulty here has been to find economical inks which will not change in body either with time or with machine speed. Actually we have not found such inks and it presents quite a problem in maintaining a uniform product to contend with these changes. It also means that we must discard any remaining ink after we have made the run since the ink we use changes so much with time that it would not be re-usable the next time we had an order for that particular color.

Ink mixing has been a problem to us, especially in getting the proper pigment dispersion to assure color uniformity. We haven't licked this but do get considerable help from a colloid mill.

Although our coatings are reasonably rub and scuffproof and water resistant, they are not as good in this respect as we would like to have them. We also have some problems in obtaining the proper opacity in dark shades since the opacifying agents which we use dilute the color so that the effectiveness of the dark color is somewhat diluted.

Foaming of ink and false viscosities which this creates are sometimes a problem. Foaming inks act like thinner inks and accordingly do not cover as well.

Although we are getting by with the inks which we use at a cost which enables us to be competitive we believe that there is room for further improvement and hope that our friends from the supplying fraternity will come up with economical inks which will have the covering values, rub, scuff, and wet resistance and uniformity of body over a long period of time that would seem to be the ideal ink for coloring machine use.

Having covered the materials that we use in this process, we would like to say a few words about equipment problems.

Efficiency with which the color is applied to the board, assuming perfect board and perfect ink, is then determined by the efficiency of the application equipment. We have seen equipment where the application was uneven due to uneven driving force applied through the gearing system that turned the applicator. Such things are obviously undesirable and usually are fairly easily fixed when they occur, but it does illustrate the necessity for proper equipment to get the desired results. We feel that it would be very desirable to be able to meter all of the ink into the press as a means of assuring uniformity of the amount applied.

We use steam driers and have found them fairly satisfactory. We are, however, experimenting with radiant heat at present in order to increase drying capacity and therefore up machine speed. Our experience has been good with the radiant heat but we are not yet ready to evaluate it against other types of heating.

We have evaluated the use of high volatile solvents and have concluded that we cannot justify the higher equipment and material costs involved.

With many of the inks that are used on these machines ventilation is a very definite problem, and must be considered in considering such installations.

We would like to be able to recirculate our inks in order to keep the uniformity that we start with, in a batch of ink. However, the changes in ink viscosity with aeration which we normally see with the type of inks we use make this impractical.

Here are a few operational problems which might be of interest. As in any web-fed operations where heating is used, the splicing material used in the rolls as they come to the machine or in the splices made at the machine must be heat resistant.

There is considerable waste due to the amount of material which must be used to thread the machine up before the color is applied. And there are, of course, butt rolls to be handled where the quantity called for does not use an entire roll of stock.

We spoke before about the waste due to having to discard the ink left over at the end of the run due to the fact that it is not stable enough to hold over for the next run. With the ink that we use, we also have some problems in connection with keeping our drains open to the sewers. This is another reason that we would like to see better inks developed.

In summary, it is our opinion that our biggest problem is the need for a low-cost vehicle with a constant viscosity which is compatible with pigments and dyestuffs and which is waterproof, scuffproof, and flexible after drying.

R. G. McCammon, General Foreman, Mill Finishing Dept., and L. K. Burnett, Assistant to Vice-President in Charge of Production, Ohio Boxboard Co., Rittman, Ohio.

Corrugated Liner—Web Printing—Production Problems

GEORGE N. HOLME

We at Stone Container Corp. have been producing colored and printed liner board for a little more than 4 years, starting this type of service shortly after the last war, our entrance into the field being delayed by the war. I shall make an attempt to point out some of the pitfalls and stumbling blocks we have encountered and some of the decisions that must be made eventually by anyone in this field of operation. In our plant the coating of liner board and the printing of over-all designs or patterns on liner board are practically one and the same, the same equipment and operators being used

George N. Holme, Stone Container Corp., Chicago, Ill.

Therefore, it is almost an impossibility to separate the problems of one from the other. Each operation does have problems peculiar to itself and where possible these will be pointed out.

The first production problems encountered in an operation of this type are not so much problems as they are facts that must be recognized and accepted. That is, that the order must "trim itself" and that there is a minimum below which it is uneconomical to perform the operation.

Acceptance of these facts presupposes that management will determine the minimum order acceptable and will provide paper of the proper size or make arrangement for the acceptance of excess trim.

Continuing with problems of the paper or stock the remaining difficulties can be summarized under the heading of nonuniformity. This in turn breaks down to three subcategories: nonuniform color, nonuniform surface finish, and nonuniform moisture. A variation in base color from the start to the finish of a roll and between rolls of stock can raise all kinds of quality control headaches. Try printing a given pattern with a given ink of a given color on light and then on dark-colored stocks, you will wind up with two entirely different effects. This also applies to coating since there is always a certain degree of show-through. We can be thankful that the base color is maintained reasonably uniform by the mills, but look out when running stock from a variety of mills on the same order!

Surface finish is perhaps subject to more variation than is color and oftentimes accompanied by uneven moisture in the board, i.e., wet streaks. A soft porous surface will absorb more material, allow more fiber to show through, and generally produce a different appearing surface than will a hard dense surface. A roll of soft board will usually be more expensive to coat than the corresponding board with a hard surface. If the soft surface appears as streaks, and generally, these soft streaks are produced by wet streaks in the board, then the finished board will also be streaked. This is usually accompanied by a drying problem as the wet streak will dry much slower and have a tendency to wrinkle. The slow drying characteristics of the wet streak also present a danger in that the remaining normal board may be overdried and embrittled.

Board that is wet, even though evenly, and soft-surfaced board are also drying problems, as they both may wrinkle and both require additional drying facilities, especially if water base coatings are used.

One last comment on the roll stock: tightly wound straight rolls are, of course, desirable as are rolls without scrap or edge trim wound in the roll. Scrap in the roll can be lots of fun if it appears unexpectedly while running at high speed, and can ruin a lot of board.

Inks and coatings are our next topic and here also some decisions are necessary before we can start. First, to be decided is, are we going to purchase our inks and coatings, or are we going to make them ourselves? In either case, we must decide whether we are going to use water base or solvent base materials. From a cost viewpoint, water usually has advantages, however, drying requirements of the solvent materials are generally much less. Solvents do present fire hazards and ventilating problems that must be considered.

Some of the properties that we at Stone Container feel a coating should have are listed below:

1. It must not be heat sensitive within the limits of the temperatures used in the corrugating operation.
2. There must be no blocking while in the roll, nor during, or after corrugating.
3. A coating that will scratch or polish when put through the corrugating and other converting operations is unsuitable.
4. As is general with all coated or printed papers, dry rub or rusting is undesirable.
5. Wet rub and bleed must be kept to a minimum.
6. Cracking or chipping at the score lines must be minimized or eliminated if possible.

G. N. Holme, Stone Container Corp.

J. W. Viner, Interchemical Corp.

7. Subsequent taping, gluing, and printing operations must not be interfered with.
8. The cost must be low.

If we decide to purchase our inks and coatings, then the supplier assumes all of the problems of formulating, mixing, and color matching; all we do is provide a portable mixer to be sure the material is thoroughly blended before we put it on the machine.

Manufacturing your own inks and coatings is often time-saving and perhaps cheaper. Facilities for formulating mixing and color matching must be provided and personnel to perform these services. The actual mixing of the color in itself is a relatively simple operation when adequate mixing equipment is provided.

There are three usual sources of color: dyestuff, pigments, and mixtures of these two. The dyestuffs generally used are the acid and basic dyes—they must never be mixed. The great strength of dyes makes them very economical, however, their light fastness is often poor, and it is sometimes difficult to insolubilize them sufficiently.

Pigments, both the inorganic and organic pigments, do, generally, have good light fastness and, of course, are insoluble. Many of them do have good color strength and they are used extensively in coatings and inks. Pigments often have another advantage over dyes in that they do provide a degree of opacity whereas dyes are completely transparent. This transparency can be both a help and a hindrance depending on the color and shade desired.

Coatings and inks of light or pastel colors present many difficulties since, as has been mentioned before, there is always a certain amount of show-through of the base-paper color.

Matching of colors presents quite a problem at times. It seems that invariably the customer wants a small spot of color from the middle of a beautiful lithographed enameled illustration done on a nice white stock—you must match it on a dirty brown stock with flat colors. This presents difficulties but even more difficult is the fact that what may match under one light source doesn't under a second or third. A beautiful match under daylight is often away offshade under the fluorescent lights of the customer's office. There are three basic light sources under which the match must be reasonably close. They are; incandescent, fluorescent, and daylight. As a general rule, we have found that a match under incandescent and then fluorescent lights will be close enough when viewed under daylight. Remember daylight itself changes. The ideal way to match colors would be to use some type of a photoelectric colorimeter that will actually measure the intensity of the various wavelengths reflected by the sample from a uniform light source with a known wavelength distribution.

This leaves us with the last source of problems—equipment. The coating and printing equipment itself can be divided into four components: the unwind section, the coating and/or

printing sections, the drying, and the rewinding sections. The rewinding section is sometimes eliminated by placing the coating or printing equipment in line with the corrugator. This arrangement means that the corrugator must be shut down when there is a shutdown of the coloring machine, and the speed of both machines is usually controlled by the speed of the coloring operation.

The unwind equipment must provide a brake for restraining the roll and means of maintaining alignment.

There are many types of coating equipment available: squeeze roll, reverse, roll, doctor roll, doctor knife, air knife, spray, brush, etc. They all have their own problems and requirements.

Printing equipment can be divided into two general processes: flexographic (aniline) and rotogravure. There is no reason for a detailed explanation of these coating or printing operations here. Sometimes high-speed operations will produce a spray from the inked rolls. This is generally solved by guarding and shielding the rolls and can oftentimes be eliminated by a viscosity change in the ink or coating. Viscosity changes, particularly in coatings, are very delicate and must be made with extreme care.

The amount and type of drying equipment are of great importance. In working with the usual corrugated liner board, we are working with materials of appreciable thickness and weight. To dry the ink or coating, usually the board must be raised to a temperature sufficient to vaporize the solvent, be it water or something else. This is where the more volatile solvents are advantageous. Drum driers are usually used, and the speed of the machine must be controlled so that the coating or printing is dry before it contacts the take-off roll. A second drum drier is of little assistance since only a small fraction of a wrap can be made around the first drum. The drying of the wetted surface by means of infrared heat rays appears to have some definite advantages.

Overdrying of the board is definitely a problem as this increases the tendency toward cracking at the scores. Apparently, there are three interrelated factors concerned with this cracking problem: the type of fiber in and on the surface of the board, the moisture content of the board and coating, and the flexibility of the coating. Minor surface cracking of the outer liner of corrugated board is often overlooked on plain board but becomes glaring when a coating of a contrasting color is applied. Often the cracking is blamed on the coating and this is unfair since the coating cannot make up for deficiencies in the paper stock.

Liner board composed of fibers with good bending qualities should always be used for web coating or printing. Overdrying must be avoided since overdrying can make the best board brittle. A very hard or brittle coating is undesirable as it will only aggravate the situation.

The rewinding equipment must be suitable for handling the heavy stocks and large rolls. It must be capable of winding straight, tight rolls and of maintaining the web tension through the rest of the machine. The web tension must be adjustable since too little tension will cause uneven and slow drying, it may allow the web to wander, and even allow the wet surface to come in contact with parts of the machine. Too much tension can cause wrinkles or breaks in the web.

All four components of the coloring machine must be in line; all of the idler rolls must be straight and true. A roll very slightly out of line at the front end of the machine may shift the web entirely off the machine at the back end.

One last word about mixing equipment before I close. Equipment should be available that can mix as little as 25 gal. or as much as several hundred gallons of coating at a time. If high solid coatings are to be used, and they are almost a must, then heavy duty mixing equipment capable of handling them is required. Some sort of grinding and dispersing equipment is also usually required.

Coloring and Pattern Printing of Corrugated Liner Stock

JOSEPH W. VINER

A most interesting story can be told of the development of the coloring and pattern printing of jute and kraft liner stock for the corrugated industries.

About 1934 this process appeared practical—i.e., machinery and the know-how were developed by the Continental Color Corp. Several machines were built; there were many trials on the best method of application and formulations of color solutions, mainly dye solutions, were attempted.

About 1935 it was felt that this was commercially possible, and several coloring machines were built and installed in the plants of several of the large producers of jute and kraft corrugated boxes.

International Printing Ink (now Interchemical Corp.) followed this development closely, saw many defects in the machine as then made, and the lack of certain qualities in the color solutions as furnished. In 1935, International Printing Ink acquired all the rights to this process and proceeded to further perfect the process by building better coloring machines and adding pigment color solutions to the field.

Dye solution had a certain value but as the stock lacked uniformity in color, surface texture, and surface penetration qualities, it was necessary to add pigment color solutions to achieve brilliant colors, cover up defects in paper, and to make the colored sheet have a commercial degree of sunfastness.

The first machines were not solidly built to hold and to draw through the machines at profitable speeds, the heavy liner stocks which varied in widths from 30 to 90 in. wide and some 12,000 ft. in the roll. Also, the first machines coated only and it was found that pattern or monogram printing was desirable. This demand caused us to combine the familiar rubber roll coating method (then called aniline coating machine) with the rotogravure pad roll or design roll to accomplish the desired effects.

Several machines incorporating these improvements were built, sold, and installed. Much money was spent on the proper pad roll to carry a good covering amount of the solution. No patents were taken out by International Printing Ink Co. as they felt it was a service, so, full information on the press was given to several press builders who, since that time, have done a good job in further perfecting the mechanical aspects of this method.

Further formula research was made to perfect all the color solutions so as to give higher drying speeds, more brilliant colors, ability to gum tape without difficulty, better water resistance, and better finish to the allover coloring.

Why this method in the converter's plant? We found that calender deck coloring was less expensive but had to be done in the paper mill and was obtainable in large tonnage. Also, it has no brilliancy and is very dull. By the coloring at the converter's plant, any width, any tonnage, could be done the same day as required and in almost any color desired. This reduces the colored paper inventory to a day-to-day basis, if desired. It cost more but the factors given above found much favor as turnover in inventory was recognized to be a big economical factor.

Also, calender stack coloring by a paper mill was limited to solid dull coloring and no opportunity for design and pattern coloring was afforded.

The development of this method of coloring and printing brought into existence a brand new selling approach for the corrugated industry. Millions are spent for magazine, for billboard, and other types of advertising—yet when a case of beer, food, radio, battery box, etc., is delivered to a customer

Joseph W. Viner, Vice-President, Printing Ink Div., Interchemical Corp. New York, N. Y.

one of these items was distinguishable as a "brand name" at the home of the user. Now, you have visually, at the point of use, the "brand name," if pattern or monogram printing is used on a beautifully colored container.

No longer do stores buy clocks, glasses, garden hose, etc., by the gross, throw away the factory packing cases, and buy paper to re-wrap each item when sold. By "eye appeal" they sell better, get less spoilage, and often are carried in the room by the buyer—if packed individually in a beautifully colored or printed carton.

Also, through this coloring method opportunities are created for enterprising sales departments to do a creative and companywise selective selling to desirable accounts, and to enter fields they never dreamed of through creation of new items.

We feel that no corrugating plant in a competitive cycle of this industry can limit itself to just good, "rough and tumble" shipping containers; but can find new life and incentives for their sales force in this field of coloring—that offers something different, something distinctive, something better—even if at a higher price.

Q. What is the approximate total cost of installing a complete set of equipment for color coating 85-in. wide roll stock and rewinding same?

A. $48,000 for a 90-in. machine complete.

Q. What floor space is required to set up this equipment?

A. Two to three thousand square feet.

Q. Does the clear protective starch coating you describe soften from the bender of the board? If so, what general steps can be taken to improve bender?

A. Coating mix does not affect bender unless it is too heavy.

Q. What special specifications, if any, are required on finish of kraft liner for colored liner? Any special sizing requirements for the liner?

A. No special requirement because the sheet is not stained; it is coated. A more absorbent sheet gives better bonding between coating and fiber.

Q. You did not mention jute liner. Is it not true that jute liner is also adequate for this use?

A. Jute is satisfactory for coating mix.

Q. What type equipment would you suggest for dispersing pigments in coatings? Do you mean colloid mills, three roller mills, or high-speed stirring?

A. Ball mill, colloid mills, and high-speed mixers. The ball mill gives the best grinding. The colloid mill does not grind to any great extent but is quite good at dispersing.

Q. Could you give a rough idea of the speed at which your aniline machine runs with different liners in conjunction with the corrugator? About how much does this printing add to the cost of the finished board?

A. Machine is not run in line with corrugator. On very absorbent board the speed is 80 to 90 f.p.m.; on better board 230 to 240 f.p.m. on coating, and up to 550 f.p.m. on printing. The printing cost is estimated at 10 to 20% additional on the cost of the container.

Q. How widespread is the practice of coloring as a part of the corrugator operation? In view of the opinion of some panel members that this is not practical, I would like to know if there are any satisfactory integrated coloring and corrugating operations.

A. There are some doing this combined job, but it is not recommended.

Q. To your knowledge, is anyone successfully printing the combined corrugated web as it comes out of the double facer before the cutoff? If so, how and what equipment is used?

A. No one is doing this.

Q. Will regular inks and type perform normally on these coated surfaces?

A. They will perform normally.

Q. You say it is better, when making a large batch of ink, to make it all at one time. Why is this so, when there are so many dangers in storing ink for a long period of time?

A. The ink is made for the entire run at one time in order to minimize shade changes between batches.

Q. Please discuss steam-set inks; the simple solubility relation between varnish and moisture; troubles with varying humidity and temperature conditions, and the remedies that operators can apply.

A. Steam-set inks are not in this field; they dry immediately.

Q. Can metallic inks be used, such as gold and silver?

A. This is not a bread and butter item; it is a specialty. It has been run since 1937. It is more costly. When stearic acid is rubbed off, the metals flake.

Q. What size engraving is required to apply a normal amount of coating mix?

A. 80-line 0.006 in. deep, and 120-line 0.003 in. deep.

Q. Can we add units to a coloring machine to laminate board?

A. Yes, a laminator can be added to a coloring machine. An applicator section and squeeze roll section are needed.

Q. Can you produce any shade using water-soluble dyes, and then match it using pigments?

A. Can match almost any shade; some deep shades are difficult with pigments.

Q. Will you explain a little more fully why printing should not, or cannot, be done on corrugators?

A. Designs should not be done on a corrugator. Tinting can be done fairly easily. It is not economical to tie up a corrugator.

Corrugated Roll Design and Chrome Plating

The Second Corrugated Container Session was devoted to a discussion of corrugator roll design and chrome plating and was held Tuesday afternoon. J. J. Koenig, Gaylord Container Corp., acted as moderator and introduced the speakers, A. W. Werner, S. & S. Corrugated Paper Machinery Co., Inc. and M. P. Boggio, Modern Hard Chrome Service Co. L. M. Walker, Chromium Corp. of America, was a member of the panel together with the speakers who discussed the questions presented from the floor.

Contemporary Flute Design

A. W. WERNER

At the time our company began studies on corrugating-roll flute contours there seemed to be considerable divergence of opinion among industry engineers as to what constituted a good profile. Our research produced certain fundamentals that are very broad in scope and which satisfied even the most skeptical observers within our organization. The principal objective of this new tooth form takes into account the physical compromises that are necessary to accommodate the variety of corrugating mediums available today.

In presenting this subject it may appear that we are being a little elementary, but the purpose is to familiarize those not intimately acquainted with the fundamentals and problems of corrugating, and to bring to the surface the reasons behind the radical change our company made as a result of its research for the ultimate in flute design.

For example, a given set of rolls with our new contour can be run "as cut" or be chrome plated after machining without changing the tooth form to accommodate the plating. When I say run "as cut" I also mean that this new contour does not require any so-called "running in" period. The rolls start making good board the instant the machine is put into operation.

A second example is that these rolls can be used to corrugate 9-point medium that runs heavy or duplex medium as thick as 0.018 or 0.020 without causing any loss in caliper, both with or without chrome plating.

The principles behind this new contour are simple now as is the case with all themes that appear mysterious before their solution. But to get into the subject, I refer you first to Fig. 1 where we see a contour that is symmetrical, i.e., the same clearance of 0.009 throughout the path occupied by the medium. Now let us assume that we receive a particular shipment of medium that runs about 0.014 in. thick. Everything else being the same, Fig. 2 shows what happens as the excess pressure on the sides of the flutes compels the rolls to separate, reducing the formed flute height 0.014 and leaving a loose fitting segment of paper on the top of the flute tips.

A. W. Werner, S. & S. Corrugated Paper Machinery Co., Inc., Brooklyn, N. Y.

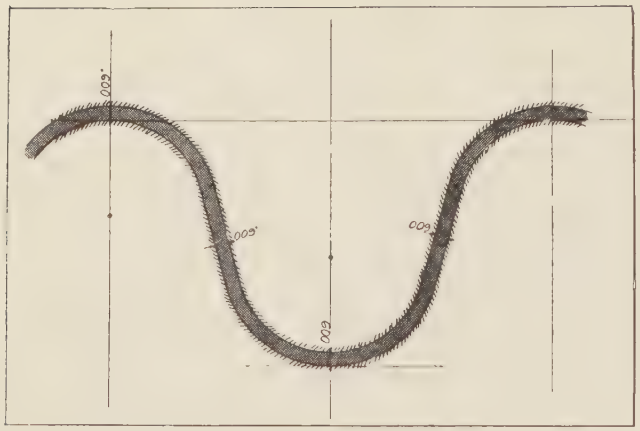


Fig. 1

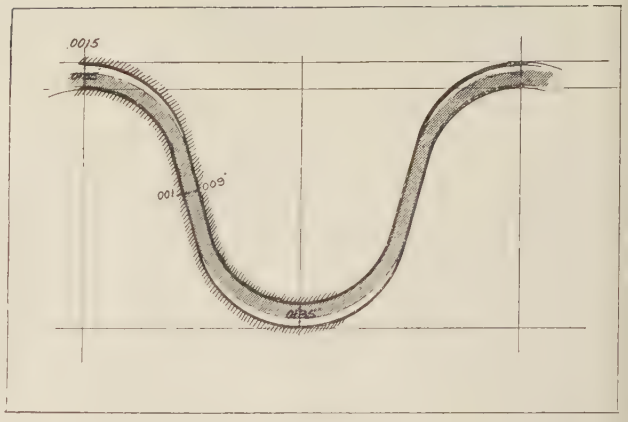


Fig. 2A

Now the shrinkage that takes place in this loose paper as a result of the heat from the rolls is likened to a flat sheet that has been moistened and placed on a hot plate without anything to hold it taut. Quickly the thick and thin, or possibly a more precise nomenclature is the dense and sparse areas of the medium, buckle or cockle. If we magnified a small area, as through cross section A-A on Fig. 2, the actual condition would appear as illustrated in Fig. 3.

If we examine this closely we see that the thin areas have clung close to the roll surface while the thicker areas have grown, swollen, or buckled as a result of the moisture pickup. While the heat drives off an equal quantity of moisture from all surfaces, both thick and thin, the more dense portion has actually taken on proportionately more moisture than the thin areas, therefore, it does not shrink down to the same theoretical line. This is what we call high and low corrugations. It is that condition which is actually influenced by the shrinkage or change in shape occurring in the thick and thin areas of the medium while being formed, and immediately thereafter, and particularly when bound on the side flanks by a tight fitting tooth form which in turn leaves that paper on the tips loose. In reality the term "high and low" is certainly a misnomer, because the whole flute, clear across the sheet, is not high nor low, but only portions of it. Since there is no more descriptive word, we will have to leave it as "high and low," but it must be understood that when we use the term we are only referring to a specific area.

We know that with bogus 9-point in the picture we have to meet a condition that is definitely variable in that different mills have a considerable variation in caliper in spite of the fact that they try to hold to definite limitations on weight and caliper. Only an experienced mill operator can appreciate the numerous problems involved in maintaining accurate caliper and particularly precise uniformity in the formation of the sheet. In fact, I ran across a sheet of 9-point bogus recently that actually measured 0.025 in. and if it had not been run on one of our machines, having this new flute contour, I am certain that it would have produced noticeable variations in board caliper and probably some mechanical difficulty. Why is this so? Let's look at Fig. 4 which shows one of our new style flutes. Here we see a decided tendency to hold the medium tight on the apex and nadir of the contour with considerable clearance on the flanks. The question that first arises, "is the lack of direct contact between the roll and the sheet detrimental?" I can only say that tests prove the superiority of the design through increased flat crush, more uniform caliper, and greatly diminished high and lows. Why? In the first place the sheet is being held tight throughout its entire span of the flute contour while being formed and retains that shape thereafter to a very large extent. The heat, either by direct contact or by radiation, sets the shape or tends to dry it out a little and does not further affect its relative height, simply because it has been firmly shaped over the tips of the flutes. In fact, there is definite pressure against the tips, ironing and setting the shape and centering itself to insure an erect and symmetrical flute.

Note here, that in this type of contour there is a tendency to put a very slight amount of tension in the web, thereby insuring a straight form of load-carrying diagonal to the flank of the corrugating medium. It is interesting to note, too, how impossible it is to get what we call "cracking" when the tooth forms are properly aligned. Since there is no pressure on the flanks of the teeth, there is never an opportunity to crack or tear the medium at this point. There can be only two reasons why so-called cracking could occur and they would be the result of utilizing almost moisture-free paper, or unreasonable misalignment of the rolls. Neither of these has anything whatsoever to do with contour design and the results of using such a dry medium would be even worse with a tight-fitting tooth form. It is therefore obvious why this type of contour gives a more uniform caliper and reduces high and lows.

But, you say, that doesn't explain the reason for increased flat crush. That question brings us to the reason why our

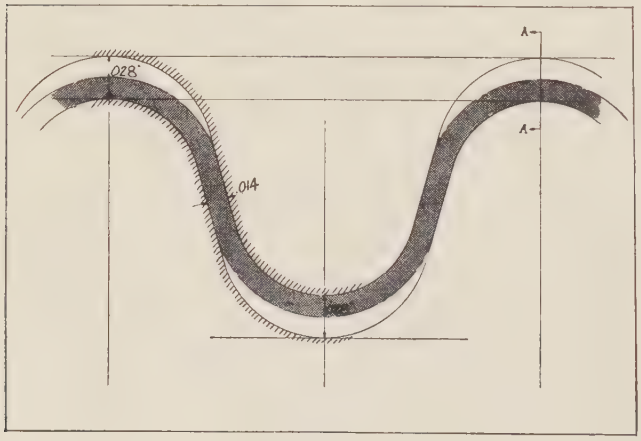


Fig. 2

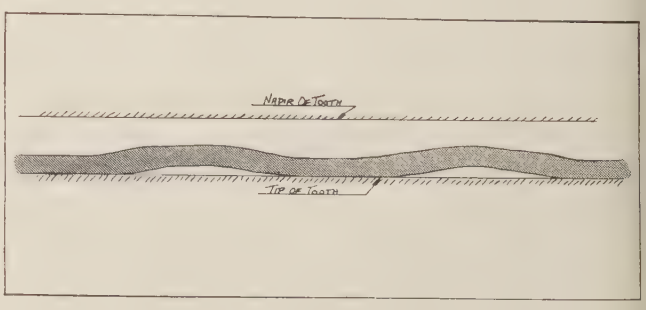


Fig. 3

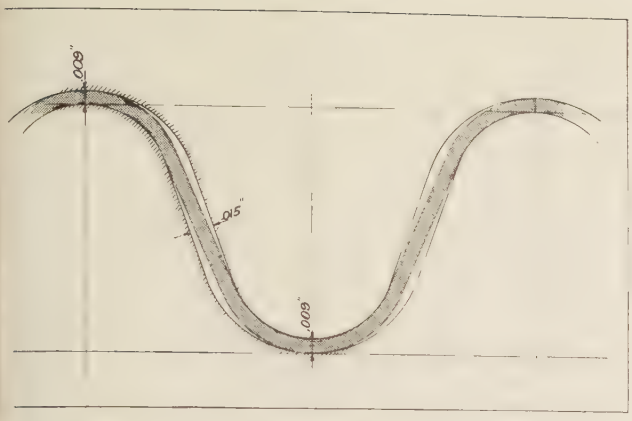


Fig. 4

mpany has employed for many years, a small radius on the s of the flutes. Flat crush could probably be calculated forehand if all the factors concerning paper characteristics ere available, because actually it follows the simple formula trusses, except for one fact, that we have what is commonly nown as a curved cantilever beam right at the point where i the bending or flexing starts. This makes the construc- on of such an equation controversial. But within the scope the physical considerations, the resultant flat crush de- nds upon how much of this curved beam is exposed to load. igure 5 shows two types of flute tip contour: one with a rge and one with a small radius. Taking into account the dhesive shoulder A, as applied to the larger radius, any oad applied at the center of the flute must be carried by this curved beam B before the load proper reaches the diagonal flank and the longer the curve B the more deflection will take place.

Figure 5A shows what I mean by deflection at the time the diagonal flank loses its function. Of course, any unpredictable condition can occur to the flank simultaneous with or just prior to the moment the curve collapses. Sometimes it remains a diagonal momentarily with an increase in load, and sometimes it assumes a letter S shape similar to that shown which results in total collapse almost immediately. I might say here, that any tooth form that attempts to shape the flanks of the medium into anything but the longest, straight line between tip and nadir, during the corrugating process, encourages early collapse with its resultant low flat crush. The totally collapsed medium is shown in Fig. 5B.

As related to the subject under discussion, it isn't so much a question as to how much the diagonal flank will carry, except we know that the straighter the flank remains, the more capacity it has. Therefore, the vital load-carrying capacity is determined by how much load the curved beam can transmit to the diagonal flank before collapse.

Now go back to Fig. 5, where we show a small radius at the

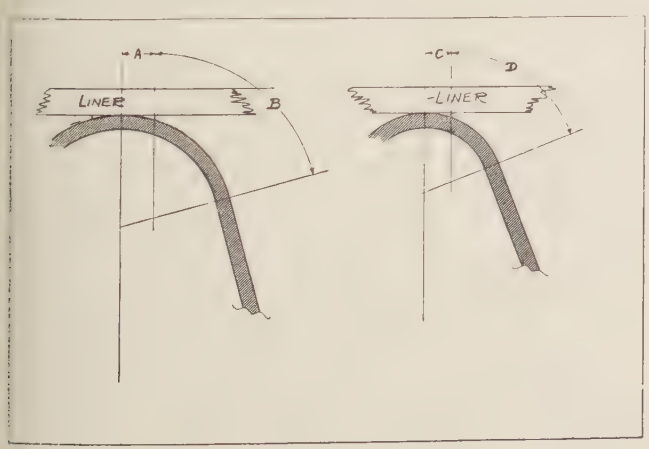


Fig. 5

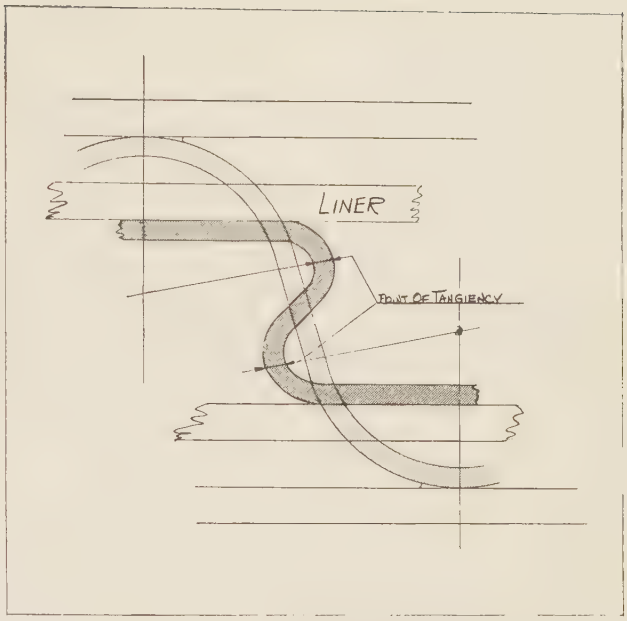


Fig. 5A

tip. After adding the adhesive shoulder C, we have considerably less curve D to carry the load, which design makes for a shorter coupled and very much stronger connection between the point of load and the diagonal flank which must ultimately carry the load. Thus, we see the advantages of a small tip radius for the optimum in flat crush.

It was pointed out before how a 0.014 medium separates the corrugating rolls an extra 0.014 when used in a set of rolls designed to accommodate only 0.009. Now let us chrome plate these same rolls, assuming that the plating will not be more than 0.0015 in. thick on the flute tips and 0.001 in. on the flanks. In order to corrugate the nominal 0.009 medium, not taking into account any thicker stock, the rolls will be forced apart 0.0135 in. as shown at Fig. 2A, reducing the caliper by 0.0045 and inflicting a condition of high and lows which in all probability would not have been present otherwise.

Figure 6 shows the ease with which rolls designed to handle 9-point but with 0.015-in. flank clearance can be made to corrugate 0.018 medium without any difficulty whatsoever. These are exactly the same roll contours as illustrated in Fig. 4. Figure 6 also shows the same contour chrome plated which still permits handling medium up to 0.017 in. thick without binding. Contrary to what happens with the conventional tooth form when using heavy corrugating materials, in this case, the thicker the medium, the greater will be the over-all board caliper.

There are two more factors that I want to bring out in this discussion that, to me, appear relevant. The first is the variation we get in checking the "take-up" of the medium per foot of liner used. All corrugating roll manufacturers will state that "take-up" is entirely synthetic; that there are

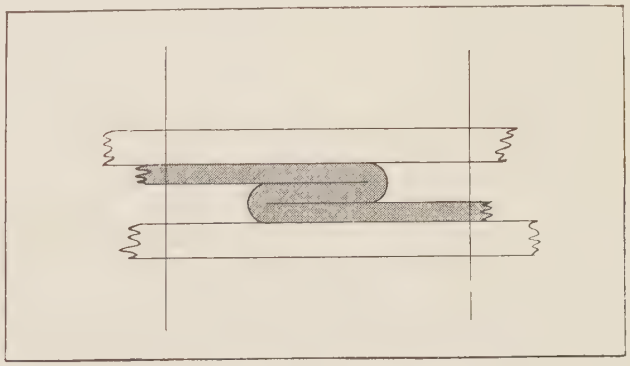


Fig. 5B

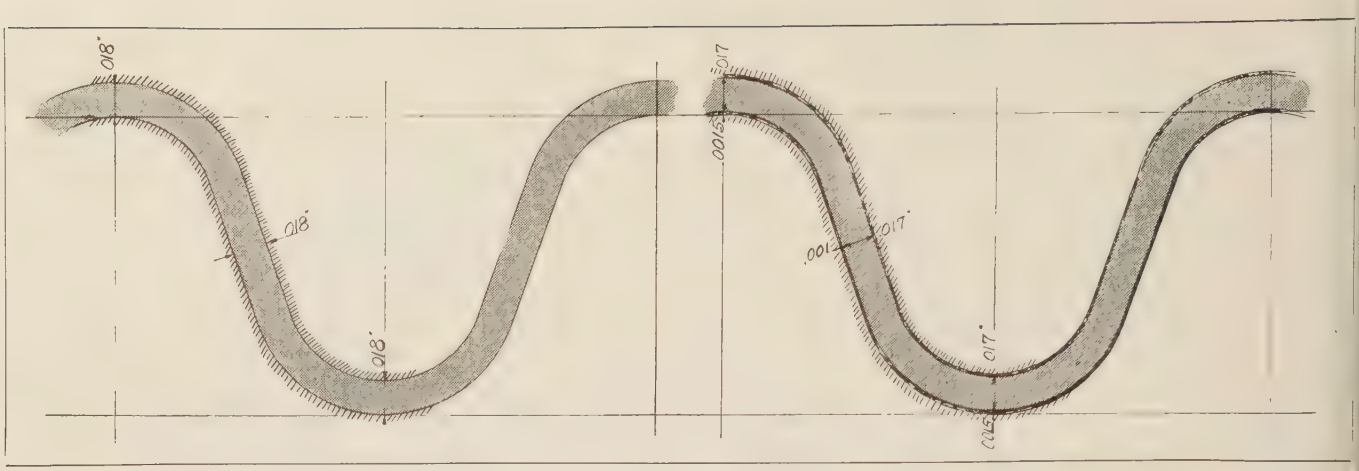


Fig. 6

numerous conditions that contribute to variations and they dislike pinning themselves down to any specific figures. Basically, there can be but one thing which can change the take-up and this is the amount of displacement occurring in the position of the corrugating rolls or to be more specific, the relative position of the two rolls with respect to each successive forming tooth. If the rolls remain in constant position or engagement, and they will if they have sufficient side clearance, then the take-up will be uniform. But, as we have seen, a flute designed to bite on the flanks for a specific caliper of medium will be constantly moving in and out while accommodating variations in medium thickness. Naturally, under such conditions the take-up will vary constantly, and no two tests on the same machine would reveal the same results. It is likewise understandable that when the rolls remain practically fixed in position, with no tendency to move in and out, the take-up could be relatively accurate. This argument does not prove so much the advantages of this new tooth form as it does confirm the statement that with variations in medium caliper, the rolls move in and out, thereby changing the flute height as well as the length of web required to produce a foot of corrugated board.

The last item of interest is in connection with leaning flutes. It has been mentioned that when considerable clearance exists between the side flanks of the teeth, there is a tendency to go off center a bit. Such a thing would be conceivably possible if there were only a line contact at the tip of the tooth, represented by an arc contacting a straight line, but since there is a small curve fitting itself to a larger curve through a semiplastic material with somewhere in the neighborhood of 6000 to 10,000 lb. being exerted between them, the tip can do nothing else but seat itself directly on the center regardless of what clearance exists on the sides of the flanks. This is just another reason why this type of tooth form always surprises the user by starting right our producing good board without numerous adjustments and sometimes hours devoted to running the rolls in. If the machine is provided with a means for aligning the flutes, and all machines are, there is no reason to believe that leaning flutes can ever occur as a result of the side flank clearance as indicated by this new type of flute contour.

Summarizing my remarks, we have touched upon the subjects of how flute form can influence higher flat crush; how more uniform board caliper can be maintained; why high and low corrugations exist; and how a specific form of contour can accommodate varying medium thicknesses as well as permit the same contour to be chrome plated or work equally well without plating. Moreover, we considered the relative merits of take-up and found that flank clearance has a tendency to make more uniform this phase of medium consumption. Lastly, we attempted to correct any false conclusions that greater flank clearances could possibly contribute to leaning corrugations, but rather improves the condition.

Advantages of Hard Chrome Plating in the Corrugator Field

M. P. BOGGIO

BEFORE getting into any discussion on the subject of chrome plating I would like to make mention of the fact that I have had 25 years' experience in a corrugated box factory: 10 years of actually working on all the machines and 15 years as a supervisor, therefore I have a very wide knowledge of all phases of the operation.

If proper inspections are made so as not to run the rolls until the chrome is all worn off, you can re-chrome the rolls without any loss to the height of your flutes or to the crown of the rolls. By not running your rolls beyond the chrome and having your rolls re-plated, you always maintain the maximum height of your flute, therefore giving a better quality board at all times.

There are two schools of thought as to when rolls should be taken out of the machine and re-plated. (1) Some companies set up a schedule and re-plate their rolls once every 6 months or once a year depending of course on the amount of footage they are running, regardless of how much chrome is left on these rolls, meaning by this, even if there was enough chrome left for possibly 3 more months of running they take them out for re-plating. They do this, of course, to make sure that they haven't harmed the metal on the rolls. (2) Many companies run the rolls until the chrome is worn to a certain point, receiving the maximun amount of footage out of the chrome. Using this method it is very important that copper sulphate tests are made on the rolls periodically, so as not to run the rolls beyond the chrome. And then there are some companies who have their rolls plated and run them until the rolls are completely worn. The idea, of course, is that they have gained many thousands of lineal feet because of the process of plating.

With chromed rolls your 9-point corrugated medium tends to fluff out of the flutes much better and because of this you are able to obtain higher speeds.

Silicate or starch adhesives will not attack chrome as rapidly as on steel, therefore, it protects the rolls for a longer period of time. Another advantage, nothing tends to stick to the chrome. This creates a much easier operating problem, because the rolls are clean at all times.

By having your fingers plated you increase their life from two to three times as compared to their normal wear. This, of course, is a money saving factor because in most cases the changing of fingers is done on Saturdays or Sundays which means time and a half or double time basis.

M. P. BOGGIO, Modern Hard Chrome Service Co., Detroit, Mich.

Chrome plating your pressure rolls saves many grindings you can maintain the diameter for longer periods. This applies to your glue rolls which saves grinding, prevents osion and pitting.

Chrome plating has proved to be very practical on score eels, slitter shafts, and slitter blades, particularly on the lex or triplex slitter shafts, score wheels, slitter holders, slitter blades at the corrugator. Because of the hot per running through them at all times it creates moisture in e area, therefore causing the shafts and scores to corrode rust. Again the same principle holds true, longer life will lt from chrome plating.

reference to all these mentioned throughout this short ission, chrome plating is a great money saving factor to ndustry. For example: let's say that you are now wear- out a set of corrugator rolls every year and you are re- ng them with a new set. If these rolls were chrome d and re-plated you would be saving more than half of original cost of the rolls. If you continue to re-plate the and you run them for 5 years you have saved your com- the difference in the cost of re-plating and buying a new very year, which represents a savings for the cost of five of corrugator rolls. If you are using A, B, and C flutes, uld mean you are saving the cost of ten or fifteen sets of in 5 years.

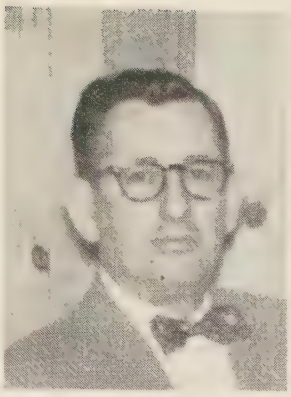
fore closing this talk there is one very important fact that uld like to stress. This is the uniformity of chrome that pplied on corrugator rolls. We all know the pains that manufacturers take in cutting of a corrugator roll to give the proper flute profile, the proper flute heights, the per crowns, and, of course, a very smooth finish. This is e to give you maximum efficiency in the operation of your hine and to get top quality board. It is equally impor- nt that the chrome plater takes the pains so as not to de- oy any of the facts just mentioned. By that I mean you not have 0.001 in. chrome on one flute and 0.003 in. rome on another. You also should have as near as possible e same amount of chrome in the valley and sides of your te as on the top so as not to distort the profile or close the arances. Another very important fact is that the same ount of chrome is applied on the ends of the rolls as well the center. This, of course, is so you won't destroy the wn in the roll that has been put in by the roll manufac- er. The reason for pointing out all these facts is that if you ide to have your corrugator rolls plated, you should be y careful in picking the company who will do this work for . By that I mean it should be someone who knows all the s I have just mentioned and a reputable company who has the experience on chrome plating corrugator rolls, as well a background of know-how.

Corrugating Roll Life

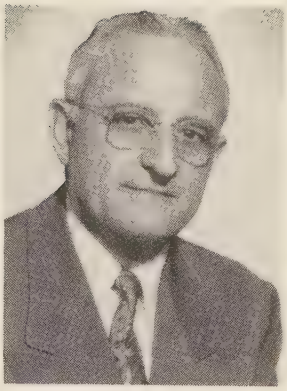
A. W. WERNER

THE subject of chrome plating corrugating rolls, its antages and disadvantages, opens up a topic that is not hout controversy. The fact remains that the findings in plant do not, as a rule, coincide with the findings in an- r. We can examine our own results and with certain peration obtain data from other plants and with this kground define the characteristic differences in roll wear, mum lineal footage, etc., but until each and every plant s the trouble to obtain dimensional data on the rolls, both re and after use, very little constructive information will gathered that will lend itself to evaluation and subsequent fit.

W. WERNER, S. & S. Corrugated Paper Machinery Co., Inc., Brooklyn,



M. P. Boggio, Modern Hard Chrome Service Co.



A. W. Werner, S & S Corrugated Paper Machinery Co., Inc.

Through such evaluation we will be able to compare data with another plant that uses the same type of medium; that has the same make and size of corrugator as well as similar operating procedures. If we stop to consider the reasons behind this type of analysis, we will understand that a straw operation cannot be compared with a bogus, a bogus with kraft, nor any variety of medium with another kind. The abrasive characteristics of all these papers are different, and it is abrasion that we are considering first and foremost in the subject of roll life, or roll wear.

Laboratory tests reveal noticeable quantities of very fine sand and glasslike particles to the extent of over 4 lb. per ton of medium. These tests were made on a recognized grade of straw. The size of the grains ranged in size between 20 and 60 mesh and varied in quantity with the finest particles showing approximately 50% more than the coarser particles. This was before jordaning. After jordaning the fines represented an increase of 1250% over the heavier particles, indicating that jordaning had a tendency of grinding down the granular matter without diminishing the over-all quantity per ton of board. There is no question about the fact that these abrasive qualities in the medium, coupled with the higher speeds we are running today, are responsible for the tremendous increase in wear occurring on corrugating rolls, regardless of the type of hardening treatment given these rolls.

Extend yourself out into the future, if you will, when corrugators will be running 1000 f.p.m. It is conceivable that two things will be required. First, the medium web will have to enter the corrugating nip with the least possible contact with the rolls, and second, the rolls will have to be made of a material probably unknown today that will be harder than chrome and be capable of resisting wear beyond our present conception. If this does not materialize before we are up to these speeds, we shall have to be a bit more practical. Because of the need for changing rolls after a certain number of operating hours, the single-facers will have to be made so that roll changes can be accomplished quickly and with fewer man-hours. At present we change these rolls about once a year and the existing provisions seem satisfactory, but if we get up to a speed range where they have to be changed every 2 months or less, certainly some different method will have to be devised.

Now with further respect to abrasion; no definite relationship between types of mediums and wear has ever been established for the simple reason that any one company invariable uses more than one type of medium during the life of the rolls and without keeping a record of the lineal footage on each. Another point is that there is no central office or individual to which these reports could flow for analysis. One company keeping records for itself reveals what might be considered a good or bad record on a set of rolls, but this has no value or relationship to what another plant experiences under the same or different operating conditions. These variables

are of considerable importance and until each is properly segregated and weighed, no real comparison of isolated results will be of value. This includes records of running speeds, lineal feet per kind of medium, corrugating roll pressures, a knowledge of flute contour, periodic checks on diameter and flute depth, and several other factors. I have named enough to illustrate that we have only inadequate means with which to compile such statistics. It would not be too difficult to keep a record of speeds since this can be done with electric tachometers, but against this record we would have to indicate the type or kind of medium used. Very few machines are equipped today with either hydraulic or pneumatic corrugating roll pressure loaders, so a continuous record of corrugating roll pressures could not yet be satisfactorily compiled. Flute contour drawings and data on crowns, up to this time, have not been too easy to obtain since most of the roll manufacturers seem to feel that this information is somewhat of a secret.

To obtain roll diameters with ordinary micrometers, after the rolls have been installed, is practically a physical impossibility, so until another method of measuring is devised we shall have to forego such knowledge, even though valuable, and just wait until wrinkling starts before we change rolls. The process is certainly primative. It seems to me that if a machined surface, or a rest of some sort were provided on the side frames or bearing retainers of the single-facer immediately above the center line of the rolls, on which a heavy straight edge could be placed, a dial type surface indicator would reveal the difference in thousands of an inch between a straight line and the roll surface and in this manner record periodic readings of wear on diameter clear across the roll. Flute depth readings are easily obtained with a micrometer depth gage, but wear in depth alone does not necessarily indicate wear on diameter because some wear occurs on the bottom of the flute. I have seen rolls wear down 0.024 in. in diameter and at the same time lose only 0.006 in. in tooth depth. This would serve to indicate that wear occurred in the valley also. This could be ordinary wear or it could be impact in the valley tending to increase the depth while at the same time the tooth was wearing off the tip at an even greater rate.

The old method of loading corrugating rolls with the handwheel and spring most generally shows the greatest wear in diameter at the operator's side. This is logical because that particular handwheel is the most convenient and if there is trouble that requires a change in pressure, the operator will use that handwheel in an attempt to correct the difficulty.

Wear seems to be associated with vibration of the rolls also. If we consider what has been said before about contours that fit tightly on the side flanks and which prevent bottoming, we can visualize considerable vibration as the individual flutes try to accommodate variations in medium caliper. Are you aware that in corrugating C flute board there are 33,600 impacts per min. with a machine speed of only 400 f.p.m. This is ten times more impulses than a 60-cycle light receives, and it is pretty hard for the eye to detect the gap in applied force there. However, it should serve to impress everyone with the number of hammer blows that are being exerted on these teeth and especially when we realize that that force is somewhere between 6 and 10 thousand lb. I have always felt that there is not so much wear on a roll as there is peening, or forging, but to prove my point, we would have to take photomicrographs of the metal structure at the base of the flutes before using the rolls and again after they were worn out. I have yet to find anyone that would sacrifice even a small piece of a *new* roll in order to have these photos taken.

In addition to chrome plating rolls, which is intended to increase the wearing qualities, we have experimented with nitriding on nitralloy with little physical and certainly no economic advantage. With nitrided rolls, a loss of 0.006 in. in A flute depth occurred at about 40 million lineal ft. These rolls were removed at this point in spite of the fact that the were running well because of loss in over-all board calipe From this we can see that where board caliper is considered part of a quality control program, the cost of nitrided rolls not justified since chrome plating would have performe equally well and at far less cost. We can also see that r gardless of the type of material used in the rolls, it is wear the flutes that appreciably affects the quality of the board.

If we had gathered roll life records from the entire industr the data would not necessarily have been any more conclusiv because of the lack of associated data, so we have taken re ords from just a few plants that operate at speeds averagi in the neighborhood of 400 f.p.m. to indicate the actual li span, using different types of corrugating roll materials.

Nitrided roll lasted	60 to 80 million
Unnitrided rolls lasted	18 to 30 million
Unplated chrome-moly lasted	30 to 50 million
Chrome-plated chrome-moly lasted	50 to 75 million per plating

Of course, there are exceptions on both sides of these figur and isolated cases may register much more or much less tha have quoted, but the figures, as stated, seem to be the conse sus of life expectancy from a large number of plants.

Another case of C flute nitrided rolls ran 42 million ft. wi 0.032-in. decrease in diameter and from 0.012 to 0.016-i loss in flute height. Here it is evident that no peening curred but that all wear was off the tips of the flutes. Act ally this particular plant must have been running very hea medium or a web width equal to the width of the machi otherwise they would have lost the tension on the sheet soon as the wear was equal to or greater than the thickness the 9-point sheet. When this happens there is no pressure any point on the web, particularly on the edges, except, course, where we find tight fitting flanks. Here we would side contact but no contact on the tips of the flutes. Suc condition would produce high and lows in abundance.

Some plants have found that there is more wear on t small top roll than on the main roll, while others have fou the wear to be the same on both rolls. However, one pl made a special installation by having the top roll made same size as the main roll and proved to their own satisfac that this was an improvement. I bring this out here beca there is a limit to the size relationship that can be emplo As the rolls get larger, the arc representing the outer diame flattens out and 12 in. seems to be about the maximum dia eter where both rolls can be the same size. Take the S. S. 16-in. main roll, for instance, two 16-in. rolls running gether would not work as well, especially on B flute, beca the medium would find too much resistance zigzagging its w into the nip. When we get above 12 in. one large and small arc work much better together, and in reality result relatively less wear because of less web pressure against teeth at the point of formation.

I believe that we can agree that most corrugating pla that have used chrome-planted rolls have become satis that this type of roll represents the most in economy. spite of metallurgical progress during the past 10 or 15 ye nothing has been presented that tends to overcome the ene of wear as economically as chrome-plating. The operatio plating rolls has also improved immeasurably during past few years, the electrodeposit being far more uniform w a noticeable decrease in flaking. It is quite possible that technique will continue to improve, and we may some time the not too distant future, have rolls with a different pla material that will run 100 million ft. at high speed and with only a slight amount of wear.

I am thinking of the new process of flame plated tung carbide which is being introduced by The Linde Air Reduc Co. While this process is quite new, I understand that the posit can be laid on anywhere from 0.0005 to 0.020 in. th ness. It consists of 92% tungsten carbide and 8% cobalt

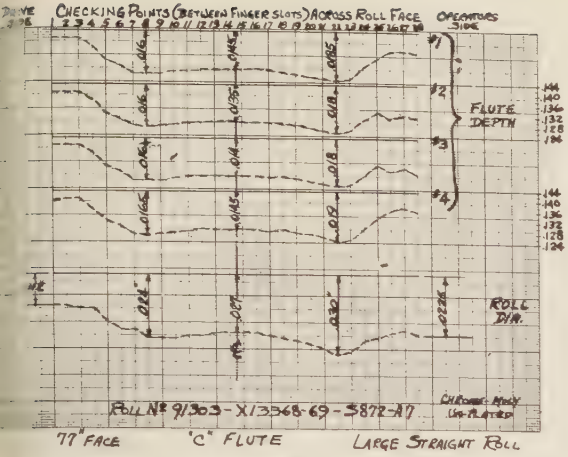


Fig. 1

posed to outwear chrome plating about 20 to 1. To here are no records to substantiate these claims but it is sting to know that something new has been brought to ttention to investigate and possibly to use.

plant here in the East ran a set of chrome-plated rolls nillion ft. and to a point of 0.013-in. loss in flute height removing them from the machine. The speed in this was not excessive, probably not over 300 f.p.m. average. to World War II, roll life averaged 60 to 80 million ft. rome plating and in a few isolated cases much more, but peeds were well below 350 f.p.m. maximum. In most we ran the rolls until the plating wore through and well into the base metal. With all this we experienced at t 50% more life than without plating. Today, we run the , not through the plating, but down to where the steel ins to show through. They are then removed, stripped, re-plated, with the process repeating itself over and over, by increasing the roll life manyfold.

Ordinarily the reduction in flute height in unplated rolls to a nt equivalent to the medium thickness is the limit of wear. this point wrinkling and waste begin. Wrinkling is the lt of loss in tension on the web which, in turn, is frequently result of loss of diameter in the rolls in the area where the er is running. Some plants believe that with constant king of the flute height, they can predetermine when a set olls will be worn out and can make preparations for the nge-over long in advance. This is both logical and practi- but a knowledge of diameter loss is even more important. There is a particularly good reason for taking measurements ute depth and diameters before rolls are placed in the ma- e, whether they be plated or not. I am aware of a case

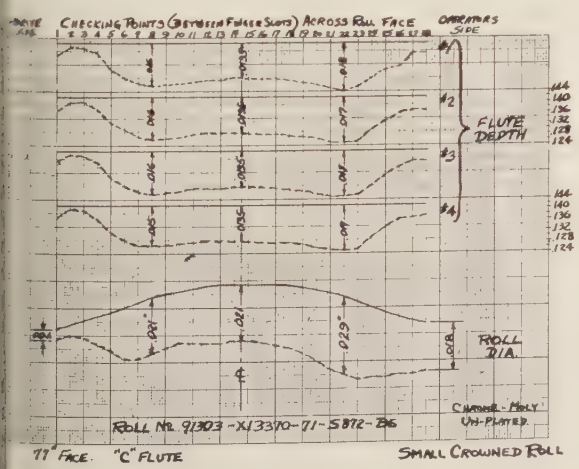


Fig 2

where the difference in flute depth between the top roll and the main roll was close to 0.004 in. and the difficulty that was encountered as a result of placing these rolls in the machine any way was sufficient to compel their removal almost immediately. Naturally, there was excessive vibration. In slow motion, it was like a man with one long and one short leg, bobbing up and down as he moves forward. Only this up-and-down motion happens so fast that it resolves itself into a series of short frequency vibratory impacts. What kind of board was made? Rather poor because one tooth was holding the web tight while the following tooth lost its tension and there was a conflict of tight and loose web in the forming teeth, a conflict which resulted in leaning flutes and manifold high and lows.

It is interesting to note that at the speeds attained today, the life of a pair of unplated rolls permitted to wear out completely is less than half the life formerly received, all things other than speed being equal. This illustrates the importance of speed related to wear. All of us have experienced a reduction in roll life as a result of our attempts to increase speed and have undoubtedly made many mechanical inspections to determine the reason. The increase in machine speed alone cannot account for all this wear, but speed in

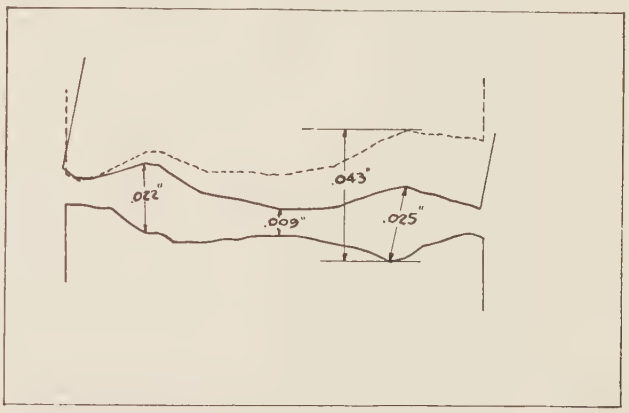


Fig. 3. Running clearances on worn rolls

the presence of abrasive material in the medium has had marked detrimental effects on the life of rolls. To say that a pair of chrome-plated rolls will last a certain number of million feet and then to neglect taking check measurements in the interim, is certainly placing our confidence in something very unreal. Some chrome-plated rolls may run 40 to 50 million ft., some may go to 100 million and very often we run into a pair that show signs of wear quite early. The real economy arising from the use of chrome-plated rolls comes from testing regularly for wear and removing them just as soon as the steel begins to show through. In this way the basic tooth form is not altered and the protecting film of chrome permits using and re-plating several times before the tooth form is finally peened or forged or possibly damaged beyond repair. Another way of checking flute wear is to record board caliper, then reduce this by the thickness of the two liners plus the medium thickness. The result will be the roll flute height minus the shrinkage. Now, since the shrinkage changes with types of paper and speed, the method is less dependable than actual roll measurements. It is merely an approximation of tooth wear.

It is interesting in checking Figs. 1 and 2 to see the effect of edge tension on wear. Even a straight roll shows considerable wear approximating a crowned roll within the range of average roll width. Most revealing is Fig. 3 which shows two rolls with one inverted as they would be in operation. Can you see why wrinkling occurs after the rolls become badly worn? It is extremely necessary to keep the rolls snug on the medium clear across the sheet if we want control over the entire web. You can see also what is meant by the

operator's side wearing more than the drive side. By showing the top roll dotted and parallel with the main roll, we can indicate a maximum difference of 0.043 in. in wear that would normally be if the top roll did not automatically adjust itself to the bottom roll irrespective of wear. In this particular case the wear on the small roll on the operator's side was about 0.010 in. more than on the drive side, while the wear on the lower roll was 0.014 in. greater tending to create more web tension on one side than the other, a condition that aggravates wrinkling.

The use of these wear diagrams very often reveals a bad roll even before it is placed in service. While it is not the intention of the roll maker to get the crown off center, I have seen the peak of a crown as much as 4 in. off center. As pointed out before, checking for the same depth of teeth on both rolls is very important and will show up a number of things that are not necessarily being sought.

I am personally familiar with two sets of chrome-plated rolls that have been in service now for nearly 3 years and both have been re-plated just twice. Their average speed has been near 400 f.p.m. and the lineal footage that has been turned out from each of these roll sets, amounts to approximately 45 million ft. per plating. The rolls are in excellent condition today because the steel has never been exposed to wear. Frequent checks with copper sulphate indicate when the rolls should be removed. This plant takes no chances of running through the plating and injuring the original shape of the contours. The use of a Magnagage has had some degree of success in checking the film thickness of chrome plating, but copper sulphate tests really show when the plating is worn through and are a simple, cheap, and convenient method that can be applied at any time, on either hot or cold rolls and and by nonprofessional help.

It is always a good policy, when re-plating, to send a good mechanic to the plating works, one who thoroughly understands corrugating rolls, and have him dress and hone the flutes after they have been stripped of the old chrome. In this way, every bump or burr is removed from the contours and the flute form is preserved. Under such a procedure replating can continue until permanent deformation takes place either on the diameters or in the flute depth. When this begins to get irregular, the rolls can be considered worn out. This serves to bring out the great difference between nitrided and chrome-plated rolls. When the nitrided rolls do become worn, there is nothing to do but to discard them, while plated rolls need only be re-plated and they become as good as new.

Figures 1 and 2 are real and complete roll records of a pair of plain unplated rolls that gave approximately 40 million ft. service. Examination will show four solid lines at the top of the chart and one solid line near the bottom representing the flute depth and diameter of the rolls, respectively at the time they were installed. The dotted lines accompanying each solid line indicate the dimensions at the time of removal. The depth measurements were taken at the four quarters of the roll on a specific tooth which was marked with a center punch at both ends of the roll. One, two, three, and four punch marks were sufficient to identify the tooth so that subsequent measurements could be made on the same tooth. Diameters were taken across points 2 and 4 only. Checks of this kind reveal why the tooth form loses its grasp on the edges of the web and why cutting occurs on the edges when wider than average roll widths are used on worn rolls.

To summarize the reasons for rapid roll wear, I should like to repeat: (1) abrasiveness and foreign substances in the medium, (2) machine speeds, (3) differences in flute height between mating rolls, and (4) roll pressures.

The tools we have available today with which to combat these elements are for all practical purposes nonexistent. Surely the box plants, whether integrated or not, have little control over the foreign substances and abrasiveness in the corrugating medium which they are compelled to use, oth than to recommend to the mill that this factor be reduced.

Progress and economy compel us toward higher operati speeds and while we anticipate precision in our corrugati rolls, the only way to be sure we receive it is to make initi scientific inspection of the rolls before placing them in us This involves the use of permanent records with which compare conditions after the rolls have served their purpose.

Corrugating roll loaders are just now making their a pearance and while their advantages are known and appr ciated, very few machines are so equipped.

While talks of this kind are usually, more or less, historic nature, there is a great deal that can evolve from such a pre entation. If it inspires us to do something about the su ject, it has served its purpose. We are certain of one thir and that is that machine speeds will ever continue to i crease. Therefore, by deduction, we can only conclude th roll life will be less unless something is done about reduci the abrasive qualities of the medium which appears to be t one element at which we can point a finger.

Some of you may be ready to suggest calender applicati of such elements as talc or cooked starch to smooth the surfa and reduce the abrading tendency, but these are not witho added problems. The increase in moisture would certain increase fabricating difficulties and the application of dry su stances has never been successfully applied at the calend Maybe the size press application would be helpful. Oil a paraffin applications through pressure sprayers to the c sheet have not yet proved that they affect roll life in a measure. Of one thing we are certain and that is that a paper treating process, either before or after the formation the sheet, that will reduce surface friction or abrasion witho interfering with the fabrication operation is a step in t right direction.

Corrugating roll wear for the present remains a metallu cal as well as a paper mill problem.

Q. How can I justify the expense of plating rolls to management?

A. You can justify the cost of plating by: (1) increased pro duction, (2) decreased down time, (3) increased speed, (4) creased time to clean, (5) plating costs about 10% of rolls, (6) better quality.

Q. As a machine manufacturer, what would you recomm on purchase of new rolls—nitrided or chrome plated?

A. Chrome plated.

Q. Will silicate adhesive affect wear on chrome-plated r more than starch? Is this a chemical action or one of abrasio

A. Chrome will resist abrasion from silicate; very li chemical reaction is suspected.

Q. Do chrome-plated rolls require operating skill to prese the life?

A. No more than normal.

Q. Do chrome-plated glue rolls pick up adhesive as wel others?

A. Chrome-plated glue rolls have satin finish and do pick adhesive as well as others.

Q. If high and lows are a random shrinkage at the top of flute, how do you explain the regularity of the high, low, high, formation?

A. There are many reasons for high and low corrugati speed, bearings, uneven moisture in sheet, uneven heat, d rolls, misaligned rolls.

Q. What is the cost of plating an 80-in. roll?

A. The questioner was asked to discuss the problem a the meeting.

Q. Does this type of flute design lend itself to both A an flute rolls?

A. The design applies to A, B, and C flute.

Q. What would be the primary cause of chrome flaking and lodging in the corrugating medium?

A. Usually the plating will not flake. If it does, it is usu the result of faulty plating technique. Chipping is due to user. The base metal should stand up.

Q. Describe the copper sulphate test for chrome plating.

A. Clean roll, and apply a solution of copper sulphat blue vitriol with a brush or rag. If the chrome is gone a co color shows.

Q. Does chrome plating have any effect on rate of heat tr fer or final roll surface temperature?

. Walker, Chromium Corp. of America

D. P. McNelly, Fort Wayne Corrugated Paper Co.

The similarity of the coefficients of heat transmission is hat no difference is indicated.

How many times can rolls be re-plated? We have exced trouble on the third cycle with "passivity" of the base

Rolls can be re-plated an indefinite number of times. vity can be overcome by good techniques.

Would it be good practice to have new rolls run for say a or so before being chromed to be sure the crown, clearance, rofile are correct and capable of running quality board? ls are perfect, is there a possibility of distortion by chrome g?

It is not necessary to run in new rolls before plating. The nsibility of preventing distortions is the plater's.

Does chroming rolls reduce or eliminate the effect of peenin reducing flute height?

There is no evidence available about peening.

Would you recommend the use of chrome-plated rolls en metal particles are found in the corrugating medium?

Yes.

Do you plate nitrided rolls with success?

Yes.

Do you recommend periodic honing of the new contour

Use new master gage with single type hones.

What is the most abrasive type of corrugating medium?

Straw, but also any wood reduction by grinding.

Is the chrome plating deposited uniformly over all parts roll?

A flute to $^1/_2$ thousandth, B and C even closer.

How much increase in flat crush is generally experienced your flute design?

A flute, 27 to 35; C flute, 43 to 55; B flute, 46 to 60.

How do you explain the formation of low flutes which r more or less clear across the web, and in a regular pattern very other flute being low?

Low flutes clear across the roll are due to dirty rolls, and y other tooth probably due to uneven flute depth.

How much chrome is applied?

One and one half thousandths per side and tip with a imum of $^1/_2$ thousandth in valley gives good wear with a imum distortion. Distortion results if the plating is over 2

How are rolls stripped?

By a series of acid baths. Care is taken so that the base al is not pitted.

How does the cost of the tungsten carbide process compare chrome plating?

About four times higher, roll cost included.

Do you have to "run in" plated rolls?

No, not now. The rolls are no longer distorted.

How do you apply chrome on fingers?

It is applied to the wearing surface only.

What is the theoretical shape of the corrugation that should the greatest flat crush? Would this same shape also give the mum top load compression strength in the finished box?

The longest, straightest flank and the smallest tip radius. annot tie up flat crush with top to bottom compression.

Will chrome chip or peel?

Not if applied properly and the base metal holds up.

Is this new flute contour guaranteed to eliminate high and lutes?

No.

Waste

On Wednesday morning, February 18, the corrugated containers group resumed its discussions, the subject being waste. John P. Forgac, Ohio Blowpipe Co., L. J. Bloom, Hoerner Corp., and R. W. Buttery, Bathurst Power & Paper Kraft Containers, Ltd., were members of the waste panel. K. W. Max, Robert Gair, Inc., acted as moderator.

Résumé—TAPPI Corrugated Waste Questionnaire

K. W. MAX

At the outset of this summary I should like to express my gratitude to the members of the TAPPI Waste Subcommittee, Arthur Gault of the Hoerner Corp., Ralph Buttery of Kraft Containers, Ltd., and Stanley Baughman of Container Corp. of America, for their most valuable contributions in preparing the waste questionnaire.

Since the questionnaire was submitted to the industry during the latter part of July, 1952, returns have gradually been coming in. At the time of this writing 41 answers have been received, a commendable response. Of these 41 returns 40 were of sufficient completeness to be used in the following analysis.

The first section of the questionnaire asked each plant to define the major waste terms as they applied to the individual operation. There was general agreement on the meaning of gross waste. Thirty-eight plants define gross waste as all waste or all baled waste. One considers gross waste as all waste except dunnage, sample room, and office waste; another feels that gross waste should be measured before salvage.

Considerable difference of opinion was registered on the terms, net, customer, controllable, and noncontrollable. There is general agreement that customer waste is waste arising from the basic blank sheet as it is processed to its final form and that die cuts, corner cuts, and center special flap cuts are included; however, only 65% of the answers include slots and stitch tab cuts as part of customer waste. Four plants consider press end trim, and two, in some instances, consider side trim in the customer category.

Although all answers to the term noncontrollable waste included customer waste as the chief constituent, the other sources were controversial. Only 75% of the answers include railroad or outside damage and only 62% include dunnage or nonroll stock sources. Several consider sample room waste and experimental waste as noncontrollable. A few even add side or end trim to the accounting of noncontrollable. Some feel customer and noncontrollable are the same.

About 68% of the returns specifically state that net waste and controllable waste are identical. From the tone of these definitions it would appear that careful thought had been given by these plants to terminology. Net waste, a percentage used by accounting methods, is composed of those items which are controllable by careful manufacturing practices. The only conclusion which can be made is that net and controllable waste are the same, and that this category can be defined as gross waste less customer, railroad damage, and dunnage.

There was general agreement that combiner waste was all waste created at or by the corrugator and that fabricating waste was all waste arising in the subsequent operations of printing, slotting, cutting, and finishing. Whether or not noncontrollable items of the type described above were deducted was individual to the specific procedure used by gross or net accounting plants.

K. W. Max Assistant Technical Director, Robert Gair Co., Inc., Uncasville, Conn.

In anticipation of inconsistency in terminology the industry was asked to vote its desires on an attempt by the waste subcommittee to standardize waste definitions. Ninety-five per cent agreed that uniformity was desirable. The misconceptions and lack of agreement disclosed by the individual definitions serve to emphasize the need for such common denominators.

From the analysis of answers given to the definition section of the waste questionnaire and from a study of the requirements of a systematic waste control program, several of the important terms in waste considerations have been tentatively proposed by the committee. These are offered for your preliminary inspection in the appendix. In some day of the near future, after all controversial evidence has been weighed, these terms in their corrected form will be submitted to the industry for approval and ultimate incorporation into an official TAPPI record.

In order to estimate the practical standard for levels of waste, the industry was asked to report its standard goal for the percentage of waste. Twenty-six plants reported gross waste standards from 7 to 13.5% and twelve offered net waste standards from 5 to 8%. Of these 38 plants 30 made a finer differentiation between combining and fabricating standards. Gross combining standards ranged between 3 and 7%, while gross fabricating standards fell between 3.2 and 6.5%. When net figures were offered, the combining standard ranged between 1.5 and 5% while the fabricating level was between 2.4 and 3.9%.

In their efforts to meet the standards the plants reporting gross figures showed waste percentages between 8.4 and 14.0% for a 4-mo. average. Only three of 26 bettered their standard goal. Those reporting net figures showed a 4-mo. average between 5.2 and 9.6%. Only two of twelve bettered their standards.

The importance of waste control has prompted 30 plants to organize formal programs to reduce unsalable waste. Nineteen have assigned special or added duties to supervisors for waste control but only eight plants have any incentive plan to prompt voluntary waste reduction. In six of the incentive plans operations beyond combining are subject to the bonus rate. Earnings from these incentives range from 1 to 10% of base pay.

It was felt that the nature of each operation would govern to some degree the waste level. Although this information does not indicate any consistent causes for good or bad waste figures, it is of sufficient interest to review briefly at this point. Twenty-one plants use 50-in. diameter roll stock, ten use 60-in., two use both 50 and 60-in., two use 40-in., two use 46 to 50-in., one uses 55 and 60-in., and one uses 50 and 57-in. Twenty-five plants carry 2-in. roll width increments, five carry 1-in. increments, two carry both 1 and 2-in., one carries 2 and 3-in., and one carries $^1/_2$-in. increments. Minimum roll widths range from 28 to 79 in. while the maximum widths vary from 62 to 95 in. Average running widths vary from 45 to 88 in. There was a wide spread in the average length of run figures. The linear footage run between slitter changes averaged between 1500 and 95,000 ft. Thirty-two plants state that their average production is composed of medium size boxes (8 to 15 sq. ft.) while five average smaller and two larger.

It was disappointing that the above data on operation could not be projected on the waste figures reported by the various plants. No relationship tying good waste percentages to long runs of large boxes or to large diameter, wide roll stock could be found. Perhaps the lack of uniformity in reporting may be the cause for this poor correlation.

Seventy-two per cent of the returns indicated that efforts, in one degree or other, were made to segregate and measure the various classes of waste; however, only 62% made any effort to describe in detail their segregation breakdown in the rather elaborate table provided in the questionnaire. The number of segregation categories varied from 3 to 16. The more complex systems normally could be identified with thos plants reporting net waste figures.

As a part of this section on segregation the industry wa asked to describe the method for determining customer wast Thirteen plants made this determination by computatio from predetermined unit standards, eleven segregate an physically measure customer waste, and six do both, depen ing on the source of the waste item. As an example of th latter, some plants calculate slottage and stitch tab was and physically weigh die cuts, corner cuts, and flap waste.

One of the most interesting relationships coming to ligh in the analysis of this questionnaire is one which unfort nately illustrates the vanity of the industry in its reluctance face squarely the unromantic but vital problem of waste co trol. Eighty-three per cent of the returns stated that prese programs of waste measurement and control enabled the to pinpoint and correct sources of excessive waste; only 13 were able to meet or better the standards of good operati prescribed by themselves.

In considering segregation of waste about half of the plan reported a program of purity classification and separatio Depending on market conditions some efforts are made bale separately waste items which have different values wastepaper. Those plants using asphalted components a particularly careful of contamination.

Although only nine replies were received, programs f segregation for both waste control and purity consumed fro 10 to 220 man-hr. per week. The amount of labor requir paralleled closely the intensity of the program.

Little information was received on the physical metho for handling waste. The general methods of blowers or co veyors for trim and cuts and carts or trucks for spoilage we mentioned, but no details were given.

There was little response to questions on methods adjustment to waste figures for salesmen's and custome errors. However, if any salvage can be made from any these major mistakes, only the waste from the salvage ope tion should be accountable. That salvage waste from cu tomer and salesmen errors should be considered noncontr lable; the salvage waste from manufacturing errors should added to controllable waste.

Although this description concludes the analysis of t official questionnaire, except for a few irrelevant details believe that several of the implications which can be deduc from the tone and consistency of the answers are in ord Most of the industry recognizes the importance of wa control procedures, but relatively few plants have made co certed efforts to reduce waste to its practical minimu There is a pronounced need for a standardized terminolo

In conclusion I should like to point out again the differe between accountings of waste on a gross or net basis. Gr waste figures are only a general estimate of the efficiency conversion in a plant. Depending on the nature of an ope tion gross waste can be good or bad, but when all uncontr lable items are deducted, the net figure can be a guide wh will serve as a criterion to any waste control program.

APPENDIX—SUGGESTED CORRUGATED WASTE DEFINITIONS

Gross Waste—All waste arising in the plant which is bal the percentage of baled waste to roll stock consumed.

Net Waste—Gross waste minus noncontrollable was the percentage controllable waste to roll stock consumed.

Noncontrollable Waste—All waste not subject to reduct by careful manufacturing methods; this category inclu customer waste, dunnage, and railroad damage.

Customer Waste—All waste inherent to and characteristi the item made; all waste arising from the basic blank sh except slitter or press end trim, including, flap cuts, sl stitch lap cuts, die cuts, corner cuts, etc.

Dunnage—Extraneous waste arising from sources ot

roll stock, such as car liners, roll cores, starch bags, , and wire boxes, miscellaneous, etc.

ntrollable Waste—Same as net waste; that waste which e minimized by careful operating practices.

ilroad Damage—All waste arising from roll stock damaged to receipt in the plant.

mbiner Waste—All controllable waste collected at or outable to the corrugator; all single facer waste except age and railroad damage and all cut-off waste including rim, splices, loose paper, reject sheets, and sheets rejected er fabricating steps attributable to combining.

bricating Waste—Sometimes called Box Shop Waste; aste, except customers' waste and dunnage, arising be- the combiner and the shipping room. Rejects attrib- e to combining errors are charged back to Combiner e.

Waste Collection Equipment

JOHN P. FORGAC

Now more than ever before there is a new and greater asis placed on scrap removal systems on a plant-wide These systems are an important factor in regard to the al scheme of production. Modern machines and in- ed production with the consequent increase in scrap and have made the removal of this waste a primary problem. simplest form of scrap disposal consists of raking the trim cutouts and shoveling them into scrap trucks. The ond form of disposal suggests the placement of the scrap- ducing machines over a conveyor which carries the scrap ectly to the baling equipment. Naturally, the conveyor t, which is first set in a trench at the right place, terminates acent to the baling press. The third form provides ry machine or every other machine such as printer slotters, slitter-scorers, or others with large pneumatic pick-up zles. Removing trim from the corrugator by pneumatic ans is almost a universal practice.

All plants employ at least one of the aforementioned meth- . Some plants employ a combination of all three methods. s the third method which we will discuss.

On a corrugated trim exhaust system the trim is conveyed ut to the inlet of the exhauster by which it is mutilated torn rather than cut, and actually makes a better binding k for the baler. This arrangement permits the torn scrap be conveyed through the discharge piping to the collector thence to garner and baler. In this method the exhauster y be located close to the slitters or a considerable distance ay. Due to the fact that the exhauster, which must have igh peripheral speed to overcome the trim feed, and a high trifugal force to accomplish the tearing effect, the power uired is slightly greater than that needed by the installa- of a cutter and blower.

n the cutter and blower installations there are a number ombined cutter-blower units on the market today. How- r, these have proved to be quite expensive as far as opera- is concerned due to the constant sharpening and replace- nt of the knives. In the independent cutter and blower allations, these have proved to be somewhat more effi- t since the cutter is operated by its own motor, likewise exhauster. In this case also the cutter or chopper requires ntenance, sharpening, and replacement of knives occasion- . The use of cutters for scrap removal is gradually be- ing obsolete.

n the various methods mentioned for the removal of scrap m the corrugator, the most efficient to date has been the cially designed exhausters with special steel wheels of extra heavy construction. These require no more maintenance than a periodic lubrication and inspection.

Of the various types of independent cutter and blower installations, the cutter usually requires approximately 2 hp. to operate and the blower approximately 5 to $7^1/_2$ hp. depending upon the length of piping and design of the system. On the special type exhauster installation which uses the mutilating principle, the horsepower required is approximately 10 for average systems ranging up to 200 ft. in length, and 15 hp. up to 400 ft. in length. In these cases, the length referred to is the combined suction, discharge, and equivalent elbow lengths in order to determine the pressure loss. The method employed in removing trim from printer slotters or slotter scorers and others is by means of a pick-up nozzle located conveniently to the operation into which the scrap is periodically swept, raked, or conveyed. Using discretion when feeding material into these nozzles will guarantee satisfactory operation for a long period of time on this type of system.

The exhauster is usually operated by a 15-hp. motor on single pick-up nozzles or 30 hp. on double pick-up nozzles, again depending on the design of the system.

On some printer slotter installations a fully automatic system is employed. The use of trim pick-up is advantageous in some cases where trim is excessive, and the slots and stitch laps are exhausted from a hopper below the slitters. Both the hopper and nozzles are interconnected and either or both can be used, depending upon the operation.

Practically every fiber paper and boxboard plant in operation today maintains some sort of exhaust system which operates with various degrees of efficiency. A great number of these, it must be admitted, operate at a very low degree of efficiency. The reasons for this condition are many and widely diversified. Some of them may have been homemade affairs which were constructed by the cut-and-try method without recourse to proper exhaust system engineering data or knowledge. Or, although they might have been adequate at the time of their original installation, now, due to changes to more modern equipment with greater production capacities, have become only partially efficient.

Modern scrap removal systems are designed to be extremely flexible to allow machines to be placed in locations where they can operate most efficiently. Engineering and designing of the scrap removal systems have become an exact science and the improvements that have been made in modern scrap removal systems are as marked as those in any other field.

A number of fan manufacturers are experimenting, with the cooperation of some plants, on the design of various fan blades to overcome the scrap removal problem. Only recently we were in a plant where they informed us that the manufacturer of the fan had changed blades the third time in order to check the various designs. In such cases as this it is beneficial to the manufacturer of the fan since it gives him a specialized product, and also to the paperboard industry at large since they will have the benefit of proper equipment to overcome their problem.

A great trend toward fully mechanized and pneumatic scrap removal systems has been gradually started. Thus in the very near future it may be possible to dispose of all scrap trucks in a plant. Now placed on the market by a few equipment manufacturers are the so-called paper shredders but up to date only the light models to handle ordinary paper waste have been obtainable. Recently installed in a very large paper company was a shredder intended for corrugated waste, imperfect corrugated boxes, cardboard, and general paper stock. This unit is in operation and is giving a great deal of satisfaction, and is handling with a 30-hp. motor 1 ton per hr. of the material mentioned. Thus equipment of this nature may be the answer in removing scrap from the various die press operations where most of the large scrap removal problems are encountered.

P. FORGAC, Design and Project Engineer Ohio Blowpipe Co., East eland, Ohio.

Information obtained from numerous plant surveys shows that this has been a stumbling block to many a successful scrap removal system. Every scrap removal system is obliged to be more or less a custom-built job as each installation presents special problems. While engineering data, formulas, and tables are readily available regarding friction losses, air volume, pipe resistance, and separator designs, other factors must be considered such as: (1) type of plant, (2) class of work done, (3) type of material used, (4) location, size, and type of each machine to be served, (5) whether scrap is to be baled or processed, (6) whether the system is to be designed for minimum power consumption or minimum first cost. Where power cost is high the system is usually selected to do work with a minimum amount of power. Where power cost is low, the first cost is usually kept low even though power requirements are higher, (7) the number and size of connections for each machine, and (8) type of storage bin and capacity.

The usual method we employ is to make a floor plan of the plant showing the location of all the scrap producing machines to be served, the relative position of baling equipment or process area to which the scrap is to be conveyed with an approximate location for the cyclone or separator.

The machines are then listed with type distinctions together with the character of scrap material to be exhausted. The connections to the various machines will vary according to quantity, type of material, condition, speed of cutting, and so forth, and are best dictated by actual experience which can only be obtained in the field. The pipe leading to the machines must be of sufficient diameter to afford an area great enough to convey the scrap economically, but not large enough to result in a direct waste of power. It is desirable to keep the air velocities throughout the system consistent with the requirements of removing the scrap without clogging the pipe. In some systems where there is a possibility of clogging we have installed relief valves which we term safety valves since they prevent the collapsing of the main suction line in such event.

The exhaust fans are subjected to severe stresses and strains because they are forced to withstand the pounding of large bulk which is fed intermittently into the system, striking the rotating fan wheels at velocities greater than 60 miles an hr. Good exhauster construction calls for the housing to be fabricated of heavy steel plates well reinforced to provide the necessary rigidity and stiffness. The belt drive arrangement is preferred because of its adaptability to speed changes and its general flexibility for maintenance. Extra heavy pedestals built widespread at the base are commonly used to take the belt load.

There are several special types of exhausters available for scrap removal installations, and each seems to have its own merit, and have been successfully used on some installations.

The first consideration for the selection of the cyclone separator is that it be of ample size to provide good separation and be designed to reduce back pressure and power required. In operation the mixture of air and scrap enters on a tangent at the cylindrical top of the separator and a centrifugal action is set up by the whirling motion which causes the material in the air to be propelled against the side of the separator and to spiral down to the cone or hopper as it is termed, while the free air exits through the tubular guard or internal stack in the center of the separator. When a single separator is used to serve more than one system a back draft damper is used to prevent one from blowing back through the other when either would be stopped for any reason.

Where the scrap is baled it often is necessary to discharge the material into a storage bin or garner having sufficient capacity to hold the continuous flow of material for at least a full bale. The storage bin or garner design varies as the design of the system and depends largely upon the location of the baler since it is connected with the operation of the baler.

This brief outline only serves as an example of the procedu followed in the designing and engineering of a satisfacto scrap removal system; and I might add that in conversati with another of our older men who has managed to arri here after a trip farther west to several plants which ha systems installed by us and others, that we believe it will so be possible to incorporate much of the larger broke into th systems by the adoption of other equipment with which will experiment.

A Waste Control Program

L. J. BLOOM

THE problem of waste control is a never ending j requiring constant attention on the part of management a worker alike. Since it is difficult to maintain continu interest in waste control we have found the use of the incent principle to be particularly helpful in carrying on our progra

Our president, R. N. Hoerner, has always been a stro supporter of the incentive principle, and for that reason organization has done much in extending his thinking to phases of our operation. In our factories we use incenti for direct and indirect labor, supervision and waste reducti Our sales and top management positions are also on an inc tive basis. In addition, all employees participate in profit sharing program.

The application of the incentive principle toward wa reduction is not a recent development with us. We have u a wastage bonus plan of one description or another for o 15 years but it has only been within the last 3 years that adopted our present plan. We do not claim that our pla the last word in perfection nor do we suggest companies can be successful in waste reduction without the use of sim plans. We realize some plants are consistently keeping wa at a minimum month after month without any formali plan whatsoever, but we believe those plants to be the exc tion and not the rule. Therefore, we present what we doing with the hope that you will look upon it as a man ment tool to help create the interest so necessary in keepi waste control program alive and effective.

I wonder if many of us actually realize how much is spen our industry each year for materials. I don't doubt that are all aware of the fact that material is by far the grea item of cost but do we give it the proper amount of seri consideration it demands when we weigh it against our ot expenses? Many times we develop a good case of stom ulcers trying to reduce labor costs a few cents per thous square feet while we work the baler overtime keeping up v our scrap production. For example, in our own organ tion a 1% reduction in waste is approximately equal to a 6. reduction in factory labor cost. Oftentimes it requires a investment in new equipment to reduce labor costs any ap ciable amount whereas a saving in waste can usually be acc plished at little or no expense.

I believe that I am being fairly conservative in making statement that our material cost was reduced approxima $120,000 last year due to a large extent to our waste con program. Referring again to our organization's incen policy, a good portion of this saving was returned to the ployees.

Our organization consists of four nonintegrated corruga units and four sheet plant operations, widely scattered thro out the Midwest and Southwest, each running its own part lar type of production. It was because of the varying of production between plants that our former waste co plans fell short of accurately measuring waste performa

L. J. BLOOM, Assistant to the Technical Adviser, Hoerner Corp., Ke Iowa.

this problem in mind we decided to revise our entire ge bonus program, hoping to come up with a plan that l be based as nearly as possible on controllable waste. was our only solution to making the waste incentive tunity fair and equitable for all plants.

SEGREGATION OF WASTE

first step in the development of such a plan was to y define and segregate the different items of waste. was done by classifying all baled waste under one of the ing headings: (I) corrugator and warehouse waste, (II) ating waste, and (III) customers' waste. A breakdown se classifications is as follows:

Corrugator and Warehouse Waste
(a) Corrugator single facer waste. This is all damaged paper stripped from rolls (warehouse and railroad damage) roll ends, floor waste, dunnage (including starch bags, roll cores, roll wrappers, carliner, ink, and tape boxes).
(b) Corrugator cutoff waste. This is all splices and loose paper at the cutoff plus the waste remaining from reclaimed no. 2 sheets.
(c) Side trim. All side trim from the corrugator and all trim from the slitters, excluding waste remaining from reclaimed no. 2 sheets, is charged to this item.
(d) Corrugator finishing waste. This is all waste in the finishing department due to poor quality of workmanship on the corrugator. This consists primarily of short sheets, poor corrugation, and loose paper.

Fabricating Waste
(a) Press waste. This accounts for all end trim, stitch flaps, and slots.
(b) Press finishing waste. This is all waste in the finishing department due to poor quality of workmanship on the presses. This consists primarily of poorly scored, slotted, and printed boxes.
(c) Partition slotter waste. All waste occurring on the partition slotters is charged to this item.
(d) Box shop waste. This is all waste chargeable to the finishing machines as well as overruns that have to be disposed of as waste.

Customers' waste
(a) Die press cutouts.
(b) Corner cuts from one-piece folders and the like.
(c) Flap waste from center specials and special overlap boxes.
(d) Sample department waste.

might appear that we have gone to considerable detail r method of segregating waste but actually it has proved e a relatively simple matter to follow the breakdown as ave it outlined. Other plants may find it necessary to ify our method somewhat to fit their own operation. , it may be necessary to calculate certain items of waste ey cannot be accurately weighed. Much of the detail nnection with the segregation of waste can actually be ped without having any effect on the final results of our , but we feel this detail gives us a control whereby we can determine the spots where our waste performance needs vement.

NONCONTROLLABLE WASTE

this point we felt our segregation of waste was suffily complete to analyze it from the standpoint of control and noncontrollable waste. Some of the major items ncontrollable waste were already set apart under the items of customers' waste, but others were concealed in rrugator and fabricating waste. For example: railroad ge and dunnage were buried in the corrugator single waste, stitch flaps and slots were in with press waste, artition slots were in the partition slotter waste. It was items of noncontrollable waste that we had not dealt our former plan that caused certain inequities to exist en our plants.

weigh these items of noncontrollable waste would not be possible task but neither could it be considered very ical. For this reason we decided to establish percentage factors whereby we could calculate the weight of these items. This was done by analyzing our records for a period of time and actually computing on an area basis the per cent of waste for slots and stitch flaps. The results of this study indicated that slot and flap waste for stitch boxes amounted to 2.15% (based on $1^1/_2$-in. stitch tab), that slot waste for tape boxes amounted to 0.70%, and that partition slot waste amounted to 2.70%. As for railroad damage, we make our allowance on the basis of the claims accepted by the railroad. Dunnage, which is all other miscellaneous scrap gathered throughout the plant, was taken from our waste records and found to be 0.20% of our total tonnage used.

We then deduct this noncontrollable waste from the gross corrugator and fabricating waste to arrive at the net waste of the various classifications.

From the corrugator single facer waste we deducted:
1. Railroad damage.
2. Dunnage.

From the press waste we deducted:
1. Stitch box flaps and slots. This necessitates having the stitch box production expressed in terms of pounds which we accomplish by using a conversion factor of 145 lb. per thousand sq. ft. This was a representative figure for our companies, covering all different test boxes.
2. Tape box slots. Again our box production was converted to pounds as previously explained.

From the partition slotter waste we deducted:
1. Partition slots. In this case we used a conversion factor of 105 lb. per thousand sq. ft. because of the lighter weight material normally used in this type of production.

CONTROLLABLE WASTE

The net waste for the corrugator and fabricating departments for the most part represents waste of a controllable nature and it is this wastage that we attempt to control, which determines the amount of our wastage bonus credit.

We express our net waste percentage separately for the corrugator and fabricating departments by dividing the pounds of net waste by the pounds of material actually processed through the department. For example: a plant which runs 10% of their production in the form of sheets that never enter the fabricating departments, would only use 90% of the weight of roll stock consumed for determining the amount of material handled in fabricating. The per cent corrugator waste, of course, would be figured against total roll stock consumed.

In this manner we correct for sheet volume which cannot otherwise be done when figuring waste percentage on the customary over-all basis. Our per cent of net waste, therefore, can be likened to a carton labor cost which many of us have accepted as the best figure available for cost comparison.

To use this material for a bonus plan, we established the following bogeys for net waste:

5 % for corrugator and warehouse waste
$2^1/_2$% for fabricating waste
$7^1/_2$% Total carton waste

Each month our bogey waste is computed by allowing 5% of the total roll stock consumed plus an additional $2^1/_2$% of that portion of the total going through the fabricating departments. This is compared to the actual monthly net waste as outlined in the foregoing discussion and the result is shown as pounds of waste over or under bogey. The savings, or overage, is then converted to a money value by using the average material cost for the month.

In the case where the month shows a savings, the employees receive a credit to their Wastage Bonus Account amounting to 60% of the savings. The remaining 40% goes to the company. This 60–40 split is purely arbitrary but is based on the thinking that employees are not solely responsible for all waste reduction. Management is also continually working toward that end by better planning, better supervision, better methods, and better equipment.

In the event the month's wastage exceeds our bogey, the

employees Wastage Bonus Account receives a debit amounting to 40% of the overage. The company in this case absorbs 60% of the deficit.

We require a balance of $1000 to be left in the employees Wastage Bonus Account to act as a buffer fund for debiting the account when faulty merchandise is directly chargeable to poor workmanship. These charges might be in the form of financial adjustments made to the customer or the cost of additional operations necessary to correct errors.

Any amount over the $1000 buffer is paid to the employees. How the money is distributed to the employees is a matter for the plants to decide. Our only purpose at the General Office is to administer the plan and determine the amount available for distribution. We do emphasize the importance of weighting the employees share so that those people who are mostly responsible for the control of waste receive a greater stake in the fund. In one of our plants all employees participate to a greater or lesser degree; while in another plant, only those people who can make a genuine contribution to the waste picture are included. This would generally include roll handlers, corrugator crews, press crews, cutting operations, supervisors, and certain positions in the office that are responsible for planning. In both cases the amount to be distributed is determined in the same manner with the only difference being in the number of employees participating. In the case where a limited number of employees participate this bonus has increased earnings to such an extent that it has been a major factor in reducing turnover on some of our more responsible jobs.

For the year 1952 the employees wastage bonus accounts in our four corrugating plants were credited with $54,000 for a net controllable waste figure of 6.46%. The best performance demonstrated by any single plant for the entire year was 5.24%, with the employees wastage bonus account in that plant being credited with $28,000.

It must be remembered that waste reduction is largely th result of good supervision and good management, and a pla such as we have outlined can only be considered a tool to hel bring about the desired results.

Q. Since all boxes are trimmed at press, how can you dete mine whether a short sheet in the finishing department was c short at the corrugator or had too much trim taken off at th press?

A. It is difficult to determine whether it is short off the co rugator or press; however, it does not affect the over-all was figure.

Q. Where does salvageable waste show up? A load of shee may have a bad edge and, therefore, be waste as far as the ord for which it was made is concerned; yet a large percentage of can be used. Is the usable part not considered as part of n waste?

A. Depends upon system. In general, all salvageable mat rial considered no. 1 is not considered as waste, but waste fro salvage operation is considered net waste.

Q. Would appreciate a general description of auxiliary scr handling trucks used by speakers.

A. Wooden boxes on casters with one open end are used the plant, primarily in the die cutting department. They a used to convey the waste to the baler.

Q. On what basis is the total waste credit split up among t various participants; equally by member participating or pr rated by hourly rate?

A. Based on percentage of earnings, weight factor of 4 f corrugator operator and 1 for bundler. Employees share is c pendent on the relative contribution of the employee to wa reduction.

Q. (a) Have you any statement about time and labor savi for pneumatic over conveyer methods? (b) Is it advisable collect dust from saws and combine with other types of trim?

A. (a) There is considerable labor saved in repair and ma tenance scrap trucks and belt conveyers. The man-power c be used elsewhere. (b) It is not advisable to incorporate sa dust with other types of trim since it could create a dust haz in the baling operation.

Q. Under the waste control plan, who collects and weighs t scrap? Have you experienced much trouble with unreport bales?

Hoerner Corp. Monthly Waste Report

		Baled waste, lb.	*Non-controllable waste, lb.*	*Net controllable waste, lb.*	*Material used, lb.*	*N wast*
I.	Corrugator and Warehouse Waste					
	Corrugator single facer waste	39,450	9,214	30,236		
	Corrugator cutoff waste	38,240	....	38,240		
	Side trim	38,380	....	38,380		
	Corrugator finishing waste	6,705	....	6,705		
		122,775	9,214	113,561	3,244,734	3.5
II.	Fabricating Waste					
	Press waste	50,510	36,752	13,758	(17% sheet	
	Press finishing waste	6,705	....	6,705	production)	
	Partition slotter waste	18,040	4,323	13,717		
	Box shop waste	12,410	....	12,410		
		87,665	41,075	46,590	2,693,129	1.
						5.
III.	Customers' Waste					
	Die press cutouts, corner cutouts, flap waste, sample waste	9,060	9,060			
	Total	219,500	59,349	160,151		
	Calculation of Noncontrollable Waste					
	Railroad damage—from claims accepted by the railroads, lb.					2
	Dunnage—3,244,734 lb. total roll stock used × 0.20%, lb.					6
	Stitch box flaps and slots—9,107,467 sq. ft. run × 0.145 lb./sq. ft. × 2.15% waste factor, lb.					28
	Tape box slots 8,235,545 sq. ft. run × 0.145 lb./sq. ft. × 0.70% waste factor, lb.					8
	Partition slots 1,524,731 sq. ft. run × 0.105 lb./sq. ft. × 2.70% waste factor, lb.					4
						50

Calculation of savings	*Bogey, %*	*Material used*	*Bogey waste*	*Actual waste*	*Saved, lb.*	*Material cost/lb., $*	*Credit or debit, $*
Corrugator and warehouse waste	5.00	3,244,734	162,237	113,561	48,676		
Fabricated waste	2.50	2,693,129	67,328	46,590	20,738		
			229,565	160,151	69,414		
Employees share = +60% of pounds under bogey or −40% of pounds over bogey.					41,648	0.0584	2,432.24 c

A. Baler man collects and weighs scrap. Little trouble with ported bales.

Q. What is the practical limit to the length of pipe run from auster to baler?

A. Approximately 500 ft. is usually the practical length of ient operation for single system installations. For greater ths, booster or transfer systems are used.

Q. Do you have to take any unusual precautions on long runs, especially if they run out into the open air?

A. There is a possibility of moisture condensing in piping therefore, the system should be started 10 to 15 min. before al use to remove it.

Q. Have you been able to determine the average combiner ?

A. This question was not included in the questionnaire.

Q. The 2725 lb. railroad claims seem excessive. Would this e represent an average monthly figure? If so, to what do attribute the high figure?

A. I cannot say why the waste is excessive.

Q. The corrugator side trim of 38,380 lb. is only slightly above f the 3,244,732 lb. run for January. Even considering 17% s, this is extremely low. Is this due to the nature of business un in Fort Worth or to exceptionally good scheduling?

A. We feel 1% side trim is low and must be the result of good luling.

Q. Does waste incentive add any problem in quality control use of reluctance to throw out bad boxes?

A. Plant doing best job on waste; also, does best job on ity.

Q. Now did you arrive at your bogeys? Different between s? What is the effect of larger percentages of box parts such ds and partitions on the bogey?

A. Must decide good, medium, and bad waste performance check amount of bonus available with good performance. hecked the years' records of four plants.

Q. Do you believe special waste supervisors are worth while? t authority should a special waste supervisor have? To n should this man be responsible?

A. A man must spend much of his time on waste and the re- s will indicate when he is not active. The man should be sponsible to the plant superintendent.

Q. Do you include the weight of starch or silicate consumed on e corrugator when computing weight of raw materials loaded to the corrugator?

A. Starch and silicate are not included in roll consumption.

Q. Do your corrugator crews receive any rebate on sheets ich, though defective when coming off the machine, are subquently salvaged in part?

A. Number 2 sheets should be controlled. Estimate and arge plant for bad sheets lying around. Receive credit when vaged.

Q. Do you have a problem of overruns and if so, do you charge ack to the operators?

A. Anything going to baler is chargeable.

Q. Does any operator receive incentive bonus based upon ste percentage only?

A. The waste incentive is in addition to the labor incentive

Q. Are blower systems to segregate press end trim from slotge a practical installation?

A. It depends on the amount of scrap and the money willing be spent on such a system. A dual system is required and it uld not be considered practical.

Q. What can be done to overcome the tendency for waste to rease with higher corrugator speeds?

A. The operator must: (1) watch single facer operation re closely, (2) watch fingers, (3) watch tendency to leave more butts, (4) reduce speed on splices to reduce size of butt, (5) strict attention to quality, and (6) cutoff man must notify mediately of bad board.

Q. Why is trim considered controllable when it is necessary? minimum splices to be counted as controllable?

A. Any waste which is minimized should be noted as conllable waste.

Q. Why do you call sample room waste customer waste when s not paying for this waste?

A. It should not be considered customer waste, but it is noncontrollable waste.

Q. Does not your estimating department figure some side n into the price of cartons? If so, should not a part of side n go into customer waste?

A. Use factor for side trim in figuring prices, but it is still ured as controllable.

Q. What is box shop waste?

A. It is all waste chargeable to the finishing machines as well overruns that have to be disposed of as waste.

Q. What steps can be taken to reduce damages to rolls particularly corrugating medium in unloading from cars and in warehouse?

A. It is difficult to set down rules for fork truck operator which he will follow continually. The fork truck blades should be smooth. Adequate room should be required for storage and piles should be sturdy so that there is no damage due to falling rolls. This problem should be given constant attention.

Q. If sheet volume is untrimmed, is a correction made for side trim?

A. No correction is made.

Q. What does the over-all gross waste percentage run?

A. It is in the neighborhood of 7%.

Q. What is your estimate of a reasonable press end trim on a medium sized (8–15 sq. ft.) R.S.C. container?

A. As far as end trim at the printer slotter, there should be none, particularly on stitched containers. However, trim is allotted due to variation in the cutoff knife at the corrugator.

Q. What is the greatest cause of waste at the corrugator?

A. Side trim to corrugator and cutoff are neck and neck. Single facer slightly less.

Q. When is waste bonus distributed? Monthly or annually?

A. The waste bonus is paid monthly to stimulate interest and keep the program effective.

Q. When careful segregation is the goal, can multiple blower garners be considered practical?

A. For careful segregation, multiple blowers and garners are required or a complex system of mechanical valves, and such an installation would not be considered practical by reason of the cost.

Q. To what department do you charge press waste caused by warped sheets?

A. It is charged to the corrugators.

Q. What do you consider as the ideal printer slotter end trim?

A. I can't answer that.

Q. What are the practical ranges of railroad damage which are allowable?

A. Railroad damage is only that allowed by railroad.

Q. What is the difference between customer and noncontrollable waste?

A. It is difficult to differentiate; however, you include railroad, damage and experimental, as noncontrollable waste.

Q. Does the corrugator scheduler participate in your waste bonus? If so, what weighting factor applies?

A. The scheduler does participate in bonus plan. He should have middle weight factor in limited plan.

Q. What is the minimum trim on the corrugator?

A. The minimum trim on a 78-in. machine is between $^3/_4$ and 1 in. less than the width.

Q. Are cyclones necessary or desirable to handle blower conveyance of saw slotter waste?

A. In some cases cyclones are required for this type of waste. Saw slotter waste is actually very dusty and, therefore, the cyclone is the most desirable.

Q. What is the difference between die cuts and die trim?

A. Die cuts are the material removed from the holes. Die trim is necessary to make square sheet, and is considered controllable.

Q. What is the frequency required for reporting waste figures when careful control is sought?

A. One plant has a weekly waste report which is posted in the plant. They actually have a very close control while scrap is being made.

Q. How do you derive bogeys?

A. Bogeys are arrived at by going through records and using judgment.

Q. What does your waste control staff consist of? (How many men?) Is their cost deducted before the bonus is calculated?

A. The waste control staff consists of one man with other supervisory duties. His salary is not deducted before the bonus is calculated.

Q. What is the average square footage per order run at Fort Worth plant?

A. I do not have the figures available.

Glued Lap Box

The last session held Wednesday afternoon covered a discussion of the glued lap box with W. W. Marteny, National Container Corp. of Wisconsin, as moderator. The speakers and panel members were R. A. Thompson, Samuel M. Langston Co.; F. R. Di Franco, National Starch Products, Inc.; Charles J. Jacobs, Dewey and Almy Chemical Co.; and Alfred W. Hoffman, Container Laboratories, Inc.

Machinery to Manufacture Glued Lap Joint-Type Containers

RAY A. THOMPSON

When requested to prepare a paper for this meeting on the subject of "Machinery to Manufacture Glued Lap Joint Type Containers," my first reaction was, "Where shall I start?" So, to cover this subject fully, I shall go back several years and trace the inception, birth, infancy, and childhood of the glued lap joint container, concentrating on the machinery to produce this type of joint. I stop with the word "childhood" because I feel that the acceptance and use of this type of joint for corrugated containers are really but barely past its infancy. It will, I feel certain, be much more widely accepted by your customers, the users of corrugated containers, in the not too distant future. At the same time, I feel certain you, the container manufacturers, will find the desirability of utilizing this joint will increase with passing time.

HISTORY

I am told that back as early as 20 years or more ago, at least two corrugated container manufacturers were experimenting with a vertical joint similar to that utilized in a folding carton. They felt that there were very probably some real advantages, production-wise, in making a glued lap joint box. A considerable amount of experimentation over a rather extended period seemed to indicate that any known adhesive (cheap enough to make the idea economically sound) would not stand the rigors of moisture, rough handling, and shipping by rail. The main problem seemed to be in finding an adhesive that was highly moisture resistant and at the same time would never quite harden. It seems that the whole subject quieted down and not too much time or effort was expended on experimentation along these lines until well after World War II.

Late in 1949, the acceptance of the glued lap joint container by the railroads became a reality. For many months some of the larger manufacturers of corrugated containers in this country (as well as other interested parties) had been working tirelessly to realize this goal. Under an amendment to the well-known Rule 41, the glued lap joint container was accepted, adding another approved type of closure for a corrugated container. This acceptance came in supplement No. 30, to Consolidated Freight Classification No. 18, which provides an authorized method of forming the closure or "joint" of a corrugated box by overlapping and gluing. The author-

Ray A. Thompson, Sales Engineer, Samuel M. Langston Co., Camden, N. J.

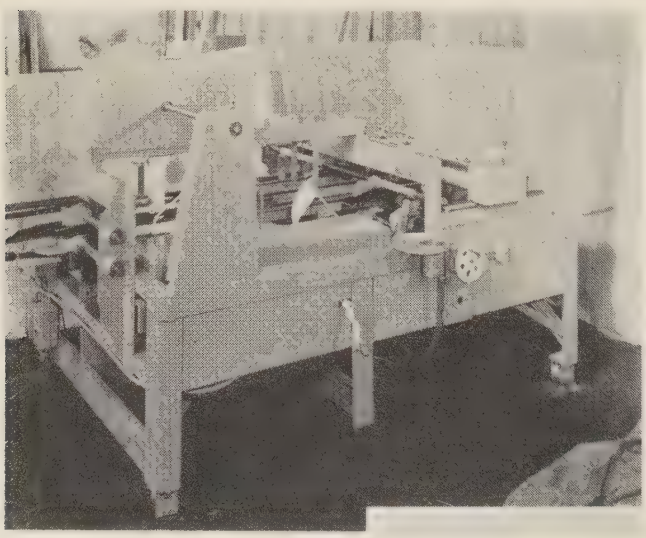


Fig. 1. Automatic folder-gluer

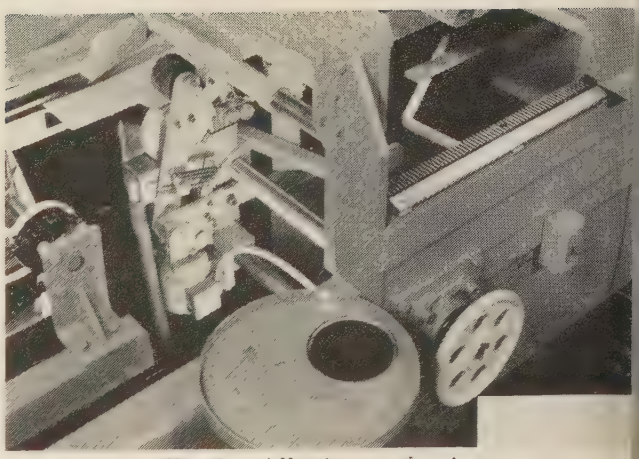


Fig. 2. Adhesive mechanism

ization was made by adding a new paragraph (d) to that pa of Section 11, of Rule 41, which covers manufacturer's join of corrugated fiber boxes.

The new paragraph states: "The sides of the box formi joint must lap not less than $1^1/_2$ in. and be firmly glue throughout the entire area of contact with a glue or adhesiv which cannot be dissolved in water after the film applicati has dried."

At that time the width of the lap for a stitched joint box w specified as $1^1/_4$ in. Before long, due to the accumulation test data which clearly indicated that the glued lap joint w at least equal to the stitched lap joint, the required widt of the lap for gluing was reduced to $1^1/_4$ in.

Hearings were held in November, 1952, on a proposal to st further modify Rule 41, to specify a 1-in. wide stitch lap, i stead of the present $1^1/_4$ in. width. If this is approved a accepted, I feel sure it will only be a short time before t glued lap width will also be reduced.

AUTOMATIC FOLDING AND GLUING MACHINE

Although some work had been done on the development a machine to make glued lap boxes prior to December, 19 the acceptance of this type of manufacturer's joint by railroads caused a speed-up in the development program i mediately thereafter. A nucleus of a machine for this pu pose was already at hand in the form of a folding machi To this was added, with considerable modification, the a hesive applicator mechanism and the compression secti after the folder, to hold the lap in position for a sufficie period of time to allow penetration of the adhesive into t liners.

Figure 1 shows the folder with the feed end at the observe right. It is fully automatic. The box blanks are placed the hopper and fed through the machine by means of a lig weight tubular, reciprocating carrier. This carrier is p manently timed and requires no adjustment or setup, t trailing edge of the blank always being in the same relati position. The feeder bar attached to one end of the carr is fitted with several serrated edge clips and grips the edge the bottom sheet of the stack, advancing it to the first foldi stage. The adhesive is applied to the lap as the box bla leaves the hopper while the blank is still flat and before a folding is done. In the foreground can be seen the adhes applicator mechanism which will be discussed in detail a lit later. The initial fold is made while the blank is stationa In the first stage it is accomplished by a pair of revolv spirals, rotating about a horizontal axis, which break the t folds to 90°.

The blank is then advanced to the second folding stage a stopped. The folding is completed by a second pair of volving spirals, rotating about vertical axes. At this po in the travel of the box blank through the machine and wh the folding is being completed, the blank is squared and

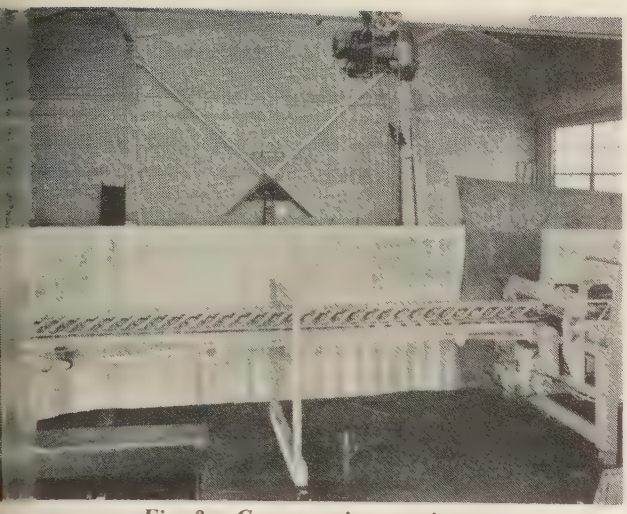


Fig. 3. Compression section

the delivery conveyor or compression section as it is times called. Irregular breaking on the score lines (if it s) is corrected by squeezing the folded panels against a center plate, one part of which can be seen at the ob- er's left. The so-called squeezing action is carried out rms which move in and out laterally, cam actuated and n from the right angle gear box which also drives the re- ng spirals. The squaring of the blank is accomplished advancing the blank before it leaves the center plate. the second stage spirals revolve, folding the blank from to perhaps 160 or 165°, there are two straight members e on each side of the centering plate) which move down- rd to complete the folding to a full 180°. This action takes ce simultaneously with the squeezing action described pre- usly. The driving mechanism for this feature is in the sed housing atop the folder.

The two folding frames (one on each side of the machine) completely separate units. Each one carries both the t and second stage revolving spirals, the squeezing me- anism, and the drives for each. Both are permanently chronized or timed, and are moved laterally by means a hand crank, one of which can be seen on the near side the machine.

In setting up the machine, the depth of the blank (or hop- size) is adjusted by one handwheel through a cross shaft a rack and pinion. Front stops or gates are adjusted for ferent thicknesses of board. Side gages are adjusted for gth of box blank. This completes the hopper adjust- nts. The two folding frames are adjusted for the proper el sizes, and the adhesive applicator wheel is positioned means of a handwheel in the right foreground, to apply e just to the glue lap score line. Calibrated scales are unted on the machine for all of the described adjustments more quickly setting up the machine.

The drive for this machine consists of a 5-hp. 1800 r.p.m. tor equipped with a variable pitch sheave driving a worm r speed reducer. A crank which is mounted on the output ft of this gear reducer drives a lightweight tubular, re- rocating carrier which advances the box blank through machine. Also mounted on the same output shaft is a ocket through which power is transmitted by means of er chain to the revolving spirals, squeezing mechanism, d overhead squaring device.

Two complete individual adhesive mechanisms are util- . One of these is used when the lap is to be glued on the side of the finished box, and the other (shown in Fig. 2) is d when the lap is to be glued on the inside of the finished x. Each of these mechanisms is supported on two small ss shafts, one of which is threaded. The latter one is fitted one end with a handwheel shown at the observer's right in the foreground. This handwheel is utilized in adjusting the adhesive mechanism laterally, dependent upon blank size.

ADHESIVE MECHANISM

The adhesive mechanism consists of an applicator roll, driven by an individual motor, and a glue pan. A knurled applicator roll is driven through a V belt drive and an overrunning clutch by a constant speed motor. The overrunning clutch allows the applicator wheel to be accelerated by the box blank passing across its face. Adhesive is applied directly to the applicator wheel, while an adjustable doctor blade controls the adhesive film thickness. The excessive adhesive applied to the applicator wheel drains down into the glue pan as the wheel is doctored and returns by gravity to the adhesive reservoir on the floor below. The adhesive pan and applicator wheel are readily removable for clean-up. An adjustable spring-loaded rubber-covered riding or pressure roll holds the lap in intimate contact with the applicator wheel.

In changing from an inside glue lap (as shown in Fig. 2) to an outside lap, the pan, adhesive applicator wheel, and their supports are removed and replaced by a different mechanism. The other mechanism is similar except that the applicator wheel and the rubber-covered pressure roll are inverted with the applicator wheel above.

You will note in the foreground the base for an inverted 5-gal. can. This arrangement was utilized on the first machine, with the well-known "chicken waterer" idea being used to feed the adhesive by gravity. Since that time all machines have been modified to utilize a continuous circulation system for the adhesive. A tank reservoir of approximately $2^1/_2$ gal. capacity is located on the floor below with a vane-type propeller circulator driven by a $^1/_4$-hp. motor. This circulating pump supplies adhesive (through a rubber hose) to the adhesive pan with the overflow returning to the reservoir. This continuous circulation assures an abundant supply of adhesive to the applicator wheel at all times, and at the same time keeps the adhesive well mixed. This type of adhesive supply system was settled upon after some trouble was experienced both with feeding the adhesive to the applicator wheel and with precipitation of the solids in the adhesives.

COMPRESSION SECTION

After the box blank has had adhesive applied to the lap and has been folded and squared, it passes to the compression section shown in Fig. 3. The function of this part of the machine is, of course, to hold the glue lap joint and the panel in intimate contact until it is, at least, partially set. The time required for sufficient absorption of the moisture in the ad-

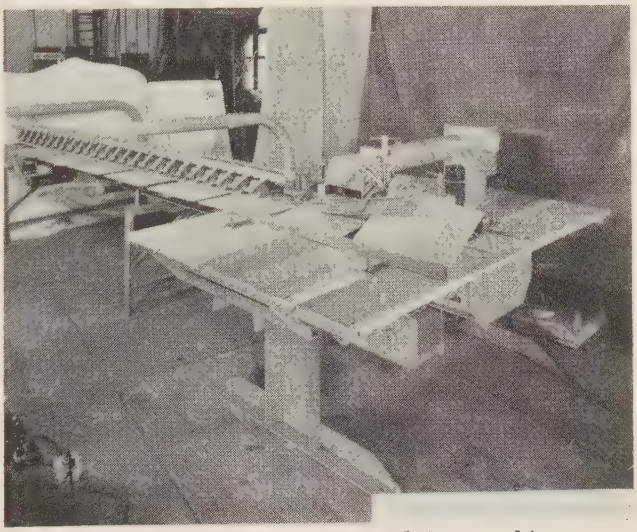


Fig. 4. Semiautomatic box gluing machine

hesive by the two liners to prevent the box from "popping open," varies, of course, depending upon the liners. Different finishes of liner board naturally react differently. Even though the joint may not be completely "set up," the adhesive will harden with passing time in the bundle.

The lower element of the compression section, which is approximately 17 ft. long, consists of a continuous traveling woven cotton belt, supported by $1^3/_4$-in. diameter table rollers, spaced on 6-in. centers. This belt is fitted with a mechanical take-up for keeping the belt tight, and it is independently driven by a variable speed drive of $^3/_4$ hp. capacity mounted on the main frame of the folder. This drive provides a maximum belt speed of 350 f.p.m. with a 10 to 1 speed range.

The upper element is made up of a series of spring-loaded soft rubber-covered rolls 4 in. in diameter. This type roll imparts a kneading action to the glued lap joint, which has seemed to form a better bond between liners more rapidly.

This machine was first built to handle a maximum blank size of 32 by 72 in. It was soon increased to a maximum of 32 by 84 in. including the lap. These dimensions allow maximum panels of 23 in. and $18^1/_4$ in. With a minimum blank size of 12 by $31^1/_2$ in., the minimum panel sizes are $8^1/_2$ and $6^1/_2$ in. The maximum depth of box which can be handled is 24 in., or said another way, the minimum top and bottom flaps are 4 in.

Due to the heavy demand for a machine of this type to handle larger size blanks, a new larger folding and gluing machine was offered for the first time late in 1952. It is capable of handling a maximum blank 45 by $99^1/_2$ in., including the glue lap, with maximum panels of 27 and 22 in. The minimum blank size is 14 by $44^1/_2$ in. with minimum panels of 12 and $9^1/_2$ in. The maximum depth box which can be handled is 37 in. or a minimum top and bottom flap of 4 in.

This larger machine is built similar to its smaller sister in every detail, including folder, adhesive mechanism, and compression section, with a few exceptions. The first folding stage, which folds the box blank from the flat position to the 90° position, utilizes two pairs of spirals instead of one. The two pairs of spirals revolve at the same speed and contact the panel at the same time. The 45-in. maximum blank depth is just simply too great to be handled by one revolving spiral; hence the two spirals on each side are required. A somewhat heavier drive, namely $7^1/_2$ hp., is employed.

SEMIAUTOMATIC BOX GLUING MACHINE

Soon after the development of the automatic folding and gluing machine, it became evident that glued lap boxes were going to be made in all sizes and shapes. As is the case wit all automatic machines, there are always odd sizes an shapes of boxes which cannot be accommodated. A re need for an open throat semiautomatic glue lap machi seemed at hand. Accordingly, work was begun on such mac hine about the middle of 1951.

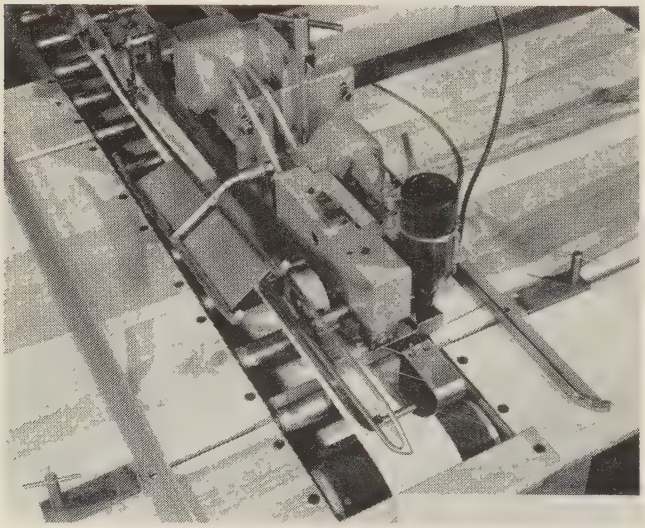


Fig. 5. Adhesive applicator

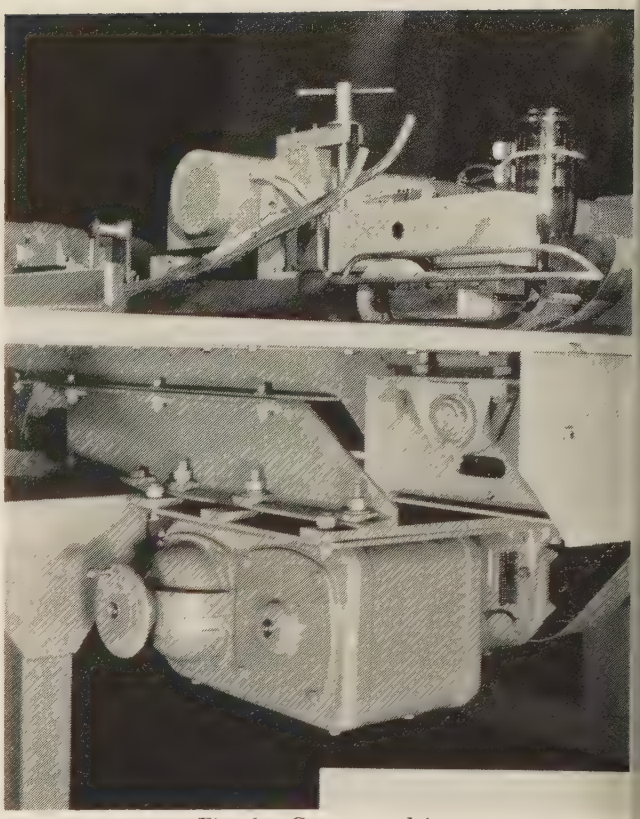


Fig. 6. Conveyor drive

The results of this development are shown in Fig. 4. T machine is comprised of a table with side gages, adhesi mechanism, and conveyor or compression section. It is bu to accommodate a conventional elevator in front of it. T operator folds on top of the stack on the elevator and inser the box blank, in much the same manner as feeding a sem automatic stitcher. The operation is sufficiently similar tha operators of either semiautomatic stitchers or tapers ca readily be interchanged between machines.

The side gages are quickly adjustable, and the curve ends help lead the blank into proper lateral position. Th conveyor belt advances the blank through the machine, wit the applicator wheel supplying adhesive en route. Th same driven belt carries the blank on through the com pression section.

ADHESIVE APPLICATOR

Figure 5 shows the details of the adhesive applicatio mechanism as viewed from the feed end of the machine. Th knurled applicator wheel is driven by a constant speed ge motor through an overrunning clutch. Adhesive is supplie to the wheel from a low volume adhesive pan by a gravi feed system from the inverted bottle. The adhesive pan fitted with a doctor blade to control the adhesive thickne

If the finished box is to have the glued lap on the inside the blank is fed with the lap end to the observer's right. Th applicator wheel remains in the same position with only suf cient clearance between it and the belt to accommodate tw thicknesses of board. The applicator wheel contacts an prints adhesive onto the glue lap.

If the finished box is to have the glued lap on the outside the blank is fed with the lap to the observer's left. In th

..., the applicator wheel position is controlled by a solenoid ...ted in the housing between the applicator wheel and the ... motor. The applicator wheel is held up by the solenoid ... the first flap and is lowered at the flap score line. The ...esive is applied on the edge of the panel between the flap ... lines, and the solenoid lifts the applicator wheel at the ... nd score line. The solenoid is actuated by two adjust- ... target-type limit switches mounted on a track for easy ...stment. The guides at the left lead the upper panel, ... either type joint, down to join the adjacent panel which ... received the adhesive. A "sled shaped" weight holds the ...k down against the conveyor belt all the way through the ...sive mechanism until the box is under the top rolls of the ... pression section.

...he compression section is similar to that described for ... automatic machine. The belt is 5 in. wide, and is of ...er impregnated woven cotton construction.

...gure 6 shows the adhesive mechanism above and the ...eyor drive below the table level. The sled-shaped ...er "hold-down" element can be seen more clearly than ...e previous figure, as well as the adhesive pan and panel ...es. The 3/4-hp. variable speed drive for the conveyor ... has a speed range of 3.6 to 1, and drives the conveyor ... at a maximum speed of 300 f.p.m.

...he only adjustments necessary in changing blank size are ... side gages in the case of the inside lap, and the side gages ... target-type limit switches in the case of the outside lap. ...changing board thickness such as changing from B flute ...rd to double wall board, the whole adhesive mechanism is ...ed (or lowered) by means of the T-wrench handle near the ...p of the figure. The limitations of panel sizes are as fol- ...ws. The maximum upper panel (after the blank has been ...lded) is 42 in. on the right side of the machine. The maxi- ...um upper panel on the left side is unlimited since this is the ...pen throat" side of the machine. This is true with the glue ...n on either the inside or the outside of the finished box.

The minimum upper panel sizes (after the blank has been ...lded) with the lap on the outside of the box are 4 in. on the ...ft side and 5 in. on the right side. If the glue lap is on the ...side of the box, the minimum upper panel is 4 in. on either ...e right or the left side.

The minimum depth box which can be glued is 8 in., due ... the spacing of the rubber-covered rolls of the compression ...ction. Of course, there is no limit on the maximum depth ... box.

There are now more than 30 corrugated box plants using ...e of these two machines. At least two of the larger manu- ...cturers of corrugated containers have developed machines ... their own for making glued lap boxes, however, very little ... generally known about either of these machines. Some ...lding carton gluers have been converted in order to run ...ued lap boxes, this latter machine being particularly ef- ...ctive on small boxes.

CONCLUSION

Other members of this panel either have given, or will give, ...apers covering laboratory test results and comparisons of ...e glued lap joint and other types of closures, operating ex- ...rience with the glued lap joint, and comments on the ad- ...sives used; hence I have deliberately avoided these phases ... this over-all subject. I think it is important, however, to ...int out some of the advantages of the glued lap joint over ...th the taped and the stitched joints. Some of these ad- ...antages are as follows:

1. On deep boxes (those with long laps), higher production ...eeds can be attained than with stitching due to the number ... stitches driven.
2. There are no stitches to scuff the contents of the box ... to discolor the contents from rust where copper stitches ...nnot be used.
3. There are no problems of tape length or tape placement.
4. There are no tape storage problems.
5. The joint will withstand high humidity atmospheric conditions such as exist in cold storage lockers.

In conclusion, I wish to repeat some of my earlier enthusiasm for the glued lap joint. If one stops to consider that it has been only a little more than 3 years since this type of manufacturer's joint first received recognition under Rule 41, the real strides which have been made are quite evident. In my opinion, the glued lap joint will very shortly cease to be an oddity, and it will take its place with the stitched and taped joints as the third standard closure for corrugated shipping containers.

The Development of Adhesives for the Glued Lap Joint on Fiber Containers

F. R. Di FRANCO

Some machines are fed by an operator who attempts to properly square the boxes along the score lines. On other machines the flat boxes are stacked and are automatically fed to the machine from the bottom of the stack. The machine applies the glue to the tab or lap and the box is folded automatically. While the method of feeding the box to a machine is not integrally tied up with the basic adhesion problem, an improperly scored box that is automatically fed is joined to give a box that is not square and has to be repaired. This condition enters into the final picture as to what is expected of the adhesive bond as you will see further.

The first major consideration for the adhesive in this assignment was how it was to be applied. Once the adhesive was in the main glue pot reservoir, most applications involved a wheel of varying degrees of knurling. To get the proper and constant amount of glue where you wanted it, doctor rollers and doctor blades were utilized. The effect of the shearing forces on the adhesive so metered imposed still another problem on the resin adhesives involved in that they had to be stable, i.e., did not break or cheese as the common parlance would have it, on the application roll.

Because of the position and size of glue pots in some instances, pumping and circulating systems had to be devised. The problem of foaming reared its ugly head here to an aggravated extent especially in an open system where it was easy to beat air into the adhesive due to circulating it and keeping the application wheel in constant motion even when the machine was not in use. This became necessary since a rather thin, quick tacking adhesive was needed for the job. If a glue wheel was stopped for a minute or so a slight skin would form. Longer stoppages aggravated an adhesives skinning condition which clogged doctor mechanisms which vitally affected the metering characteristics of the glue application.

Another method of applying the adhesives was devised whereby the adhesive was extruded through two fine nozzles that metered it into place. The feeding of the adhesive was through a closed, moderately pressured system. This imposed the problem of developing a product that did not settle or settled so little it did not affect the operation. It also required a product that when it dried on the nozzles during a machine shutdown, it skinned at the tip only and did not harden in the nozzle. All this added up to a constant feeding of adhesive through relatively very small apertures box after box, repeatedly.

F. R. Di Franco, National Starch Products, Inc., Plainfield, N. Y.

After an adhesive is put on properly on anything you are bonding, proper compression for the necessary length of time has to be supplied to complete the bond if only for handling. In this field, we encountered compression units of the belt and roller type. What was most important, however, was the amount of pressure made available to us and yet not crush the flutes and the length of time in the compression units. It was most discouraging in many cases where the compression time was barely adequate either because the unit was too short to save space or the rate of speed of the boxes through the compression unit gave the bond a scarce few seconds. With compression units care has to be taken that the type of adhesive utilized is the type that does not easily squeeze out, dries too rapidly, or is absorbed by the board too readily leaving an inadequate amount behind to do the cementing or bonding.

To our minds, the method of handling of a box as it emerges from the compression unit can seriously affect the over-all quality of a given box manufacturer.

Some merely have the boxes drop onto a stack where they are counted and bundled. Some have counterstackers which in themselves are good but what they do to the adhesive bond as they hit the backboard and jounce down is exactly what you should not do. Often a marginal setting of the adhesive is disturbed into being a rejection because of this. A shingler-stacker is the ideal situation here since it is a continuation of the compression unit while counting and inspection and finally typing and bundling take place.

Finally, we get to the consideration as to what is expected of the bond. What conditions are imposed upon it because they are necessary or because an individual manufacturer wants to build something extra into the manufactured article that he can offer to his customer as an extra sales advantage. Rule 41 of the Consolidated Freight Classification specifies a water-resistant adhesive that necessarily makes it a resin type to give the degree of water resistance expected. Some manufacturers require water immersion-proofness for 1 to 5 days even though the corrugation and the board may begin to fall apart before that. Heat resistance is required of the glue bond since containers are stored in hot warehouses and shipped in real hot railroad cars where heats reach 180°F. Good color is required of the dried adhesives film to overcome an unsightly appearance on a squeeze-out. A varying range of colors of adhesives from brown to white have been formulated with varying set characteristics. Immediate tack with slow drying is expected of the initial bond in this problem. This property was most important in squaring boxes that lined up poorly due to poor scoring. In some cases, the bond could be completely disturbed and reset due to the pressure sensitivity of the product before it dried. The final bond has to be such that if for any reason the box should have to be repaired, the adhesive should preferably not destroy the corrugation and a fresh application of adhesive should adhere on top of the dried film.

In summation of all we have had to say, the adhesive manufacturer has been able to make the products to suit the machines of the individual corrugated boxboard manufacturer. He has done it with several types of resin adhesives. They are:

1. Fast tacking and slow drying to give the necessary production speeds.
2. They have been able to make them of varying colors, brown, tan-board, color, or water white, to meet the individual needs or specification of the individual manufacturer.
3. They are water immersion proof.
4. They are mold and mildew resistant.
5. They have the necessary machining properties to give uninterrupted production at the varying speeds of the machines involved with the specific boxes being made.

Some Production Problems Encountered in the Manufacture of Glued Lap Corrugated Boxes

CHARLES J. JACOBS

The types of equipment used to manufacture glued lap boxes and development of an adequate adhesive have just been discussed by Mr. Thompson and Mr. Di Franco. The purpose of this paper is to touch briefly on the next logical topic—production problems encountered in the manufacture of glued lap corrugated boxes.

I am sure that there are many of you who have made more glued lap boxes than I have ever seen and you will probably be able and willing to assist in answering the questions concerning production problems which will be asked during the discussion period. I do not claim to be an expert in this relatively new field. However, since 1948 it has been my privilege to work with engineers of two of the pioneering corrugators in this field on adhesives and equipment problems and I have also worked continually with the engineering staffs of three equipment manufacturing companies.

No matter how carefully an idea is thought out and developed, there are always unexpected problems that arise in the day-to-day execution of manufacturing principles. To enable you to prevent some of these problems from arising or to assist you in readily determining the causes of the problems, I shall touch upon what are generally accepted as good manufacturing procedures. Regardless of the type of the equipment used, be it automatic or semiautomatic, commercially manufactured or privately built, certain precautions must be taken to ensure constant trouble-free production.

Let us assume that we are going to make some glued lap boxes, using either automatic or semiautomatic equipment with an accepted adhesive. First let us discuss the proper handling of this adhesive. Undoubtedly it will be one of the so-called resin emulsion adhesives. These adhesives are damaged by freezing, therefore, we will have stored it in a protected area away from outside walls and away from radiators, preferably at normal room temperature. Or, if this was not feasible, we will have made sure that the adhesive was brought into a warm room 48 hr. before use. All resin emulsion adhesives have a tendency to settle during storage so we will follow the manufacturer's instructions that are found on the container. "Stir thoroughly before using"—this does not mean shake or roll the pail by hand for 2 or 3 min., nor does it mean cursory mixing with a paddle. It means thoroughly. If you do it, it will pay dividends; if you don't, you may get by, but the chances are that sooner or later you will have trouble from the poorly mixed adhesive. The easiest way to mix the adhesive is to use an electrically driven mechanical mixer.

Now, let us discuss the conditions under which we are going to use the adhesive. So far as I know, all adhesives for the production of glued lap boxes are supplied at an optimum viscosity, solids, etc., and are intended to be used as received without dilution. If the adhesive is to be used directly from the shipping container by connecting it to the adhesive applying system, we must make sure that any water used to wash the equipment has been completely drained from the lines and reservoir. If the adhesive is to be transferred to a different container, we must make sure that this also is clean and dry. Not only the container, lines, and reservoir but also the adhesive applying mechanism must be clean. The attainment of trouble-free high-speed production is directly related to the accuracy of supplying the proper amount of adhesive in a

Charles J. Jacobs, Dewey and Almy Chemical Co., Cambridge, Mass.

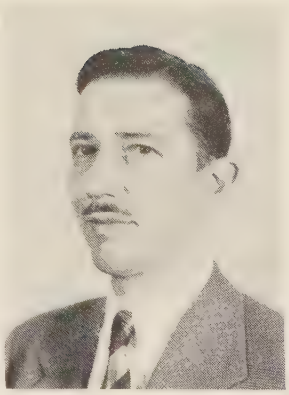
iform pattern. Just as you would expect poor results m mounting a dirty or plugged rubber printing plate over irregularity on a press cylinder, you can expect poor re- ts if your adhesive applying equipment is dirty, out of true misaligned. I know that some box shops are not the clean-, neatest places in the world, but certain pieces of equip- nt, even in the worst box shop, must be properly main- ned or they won't function. So, if you have to, neglect paint and frills, but keep the glue applying equipment n and in adjustment. A moment ago I mentioned that adhesive should be at room temperature before it is used. s widely recognized, not only in glued lap boxmaking but in other gluing operations, that cold glue does not permit h operating speeds. It has been my experience that when e or board is below 60°F. there is an appreciable decrease peed of bond formation. So, whenever possible, operating peratures should be maintained above 60°F. As far as temperatures are concerned, I have found that no diffi- y in gluing is encountered at room temperatures of 110°F. ny one is unfortunate enough to make glued lap boxes at er room temperatures than that I would like to find out they make out, but I would prefer a written report rather n to be on hand in that kind of weather.

Now our next step in making boxes is to determine the per amount of adhesive to apply. We will use the least ount of adhesive that will give complete coverage to both s of the joint after the box has emerged from the compres- unit. The use of excessive amounts of glue results in ee things: (1) slightly increased manufacturing cost, potential squeeze-out which can cause boxes to stick to h other or to stick internally, and (3) decreased production eeds. In proper operation sufficient bond strength must e developed by the time the boxes emerge from the compres- on unit to prevent the joints from opening. The rate of ond formation is determined by a number of factors: the pe of board and its moisture content, time of compression, d the amount of adhesive applied. By the time the board aches the glue lap box machine we can make no changes to . On most of the machines, the compression time can be aried and by proper setting sufficiently strong bonds can be btained. The amount of adhesive applied is the most critical ctor because resin emulsion adhesives have relatively little et tackiness and they depend upon absorption of the water om the adhesive to give strength to the wet bond. Ob- ously, the more adhesive present the more water that must e absorbed before a bond is formed. Therefore, good operat- g technique calls for the use of a minimum amount of ad- sive. It is clear that if an uneven application of adhesive made with sufficient adhesive at the lighter application ints to give good transfer, at the heavier points of applica- n an excessive amount of adhesive will have been deposited. bviously, the excessive amount of adhesive at these heavy ints will cause weaker wet bonds, and therefore operating eeds will have to be reduced. Although an increase in quired compression time may be only 1 sec., in a normal 4- c. compression period this causes a 25% reduction in speed.

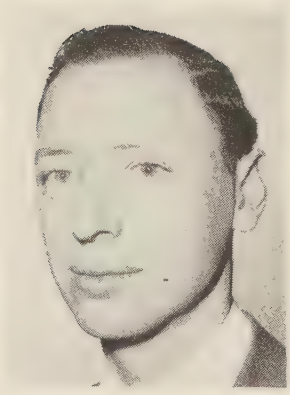
Now let us go on to the handling of boxes as they come from e glue lap machine. Although an initial bond has been rmed at this point, full wet-bond strength does not occur mediately, so the boxes should not be given any unduly ugh handling. I don't mean that they have to be handled h kid gloves, but any handling practice which tends to arate the newly formed bonds as the boxes come from the chine should be avoided.

I would like to talk briefly about a few controversial points at are often raised when glued lap box manufacturing is cussed.

What happens when a box is glued out of square? When ox is glued out of square, the inspector or bundler should n it as soon as it is discovered. Unless the box has been ed for an extended period of time, it can be opened with only superficial tearing of the liner, because the liner stock is still soft from absorbed water from the adhesive.



C. J. Jacobs, Dewey & Almy Chemical Co.



A. W. Hoffman, Container Testing Laboratories

Can boxes that have been glued once be reglued? Of course I cannot speak for all of the adhesives on the market, but I do know that some will form a bond on a box that has already been glued once and then opened, such as an out-of-square box. Because bond formation depends on water absorption, these box blanks should be held until the end of the order, glued at a reduced rate to give longer compression time, and then securely bundled immediately after they have been made.

How can boxes made from entirely different paper stocks be efficiently glued with the same adhesive? Just as corrugated board can be made from a soft absorbent sheet of fourdrinier kraft or a dense, water-finished cylinder kraft with the same corrugating adhesive, so also can these dissimilar stocks be bonded with the same glue lap adhesive. In the case of the porous stock, a little more than the usual amount of adhesive will be required to allow for the deeper penetration. The dense sheet will require a little less than the usual amount of adhesive because of slightly shallower penetration. In most cases, differences in liner stock, moisture content, panel size, etc., are not sufficient to necessitate changes in the amount of adhesive applied.

Let me summarize the key points in obtaining trouble-free glued lap box production. Use well-mixed adhesive at room temperature in a well-maintained glue lap machine. In closing I would like to stress that the possible difficulties that I have just discussed can be encountered but usually glued lap boxmaking is an easy, economical operation.

Glued Lap Joints on Fiber Containers

ALFRED W. HOFFMAN

THE position of final speaker at a panel session such as I occupy today offers certain advantages and disadvantages. On the one hand it presents the opportunity to develop certain aspects of the subject problem which have not been emphasized by the preceding speakers and on the other it presents the problem of glossing over facets which have already been brought out. Your indulgence is requested for any repetition of technical data, and the explanation is offered that certain fundamental considerations warrant an additional exposition.

Glued lap joints have been authorized for corrugated fiberboard boxes under Rule 41 of the Consolidated Freight Classification since December, 1949. Although initially they were at a disadvantage with respect to stitched joints in that a wider lap or tab was needed, this is no longer so.

ALFRED W. HOFFMAN, Laboratory Manager, Container Laboratories, Inc., New York, N. Y.

Both of these manufacturer's joints currently require a tab with a minimum width of $1^1/_4$ in. Furthermore, since the Consolidated Classification Committees just recently rejected, at least temporarily, a proposal to reduce the minimum width for stitched joints to 1 in., it is reasonable to suppose that the present parity in this respect will prevail for some time to come. The other Rule 41 requirements with respect to glued lap joints are that the adhesive be water resistant and that the entire area of contact be firmly glued.

Although Rule 41 does not authorize glued lap joints on solid fiberboard boxes, such permission is granted by at least one special package, Package 175, which covers bulk shipments of licorice extract to a maximum gross weight of 55 lb. The glue lap for such solid fiber containers (which are of 275-lb. test grade) must be at least $1^1/_2$ in. wide. However, in general, glued lap joints are currently important only in the corrugated fiberboard field.

As with stitch laps or tabs, glue laps can be either an extension of an end panel joined to a side panel or an extension or a side panel joined to an end panel. Furthermore, the laps can either be on the outside or on the inside. Some plants producing glued lap boxes make it a practice to extend the lap approximately 1 in. beyond both the top and bottom horizontal scores. These extensions are glued to the top and bottom side flap.

The foregoing description of glued lap joints may be helpful but an evaluation of their properties is more fruitful and this must be based upon comparison with those of stitched and taped joints. For this presentation we have eliminated from consideration special tape joints such as those effected in the middle of a panel and special splicing joints which also are located within a panel rather than at a vertical edge. This elimination was motivated by the fact that the special joints just cited are not utilized by the industry as a whole.

Three fields of comparison suggest themselves: price, performance as measured by laboratory tests, and inherent features which do not lend themselves readily to laboratory measurement but which are self evident. The comments which follow are the result of personal experience and of conversations with individuals concerned and acquainted with the topic under consideration. It might also be mentioned that the views of the proponents of all three types of joints—taped, stitched, and glued—have been solicited.

It happens that the relationship between glued and stitched joints can be drawn more readily than that between glued and taped joints. This stems from the fact that there are far more variations in taped joints than there are in either of the others. When one considers that tapes used for manufacturer's joints include paper, laminated paper with and without reinforcement, duplex and fiber-filled cloth, and clay-filled cloth; that in each category there are different widths and grades; and that there are subdivisions with respect to laminants, adhesives, reinforcing media, and reinforcing patterns, it is obviously difficult to establish a common norm for taped joints with respect to any characteristic. An additional complication, insofar as the relative effect of type of joint upon container cost is concerned, is that box dimensions—specifically, the length of the joint and the relationship between the area of the stitch or glue lap and the area of the entire box blank—directly influence the result.

However, to the best of our knowledge there is no difference in selling price between containers with stitched and glued lap joints. Presumably the same parity in customer price exists between glued lap boxes and taped boxes but this has not yet been thoroughly established. Several boxmaking concerns in this part of the country furnishing all three types of containers have verified the selling price relationship between glued lap and stitched containers. On the other hand, there was not the same unanimity between these companies with respect to manufacturing expense. Two organizations claim that the difference in cost between the glued and stitched joint was very slight with the former, perhaps, having a slight edge; another spoke of a slight edge in favor of glued joints, and a fourth said that glued joint costs were approximately half those of stitched joints. It would appear reasonable to suppose that the prior volume of stitching operations at a given plant and the efficiency of such operations would have a direct influence upon the estimate as to the comparative cost of the glued lap process.

For the reasons previously cited, it is almost impossible to provide an over-all comparison from an economic standpoint between glued and taped joints. Once again it is curious to note that estimates of this correlation are not uniform among boxmakers. For example, two such concerns consider glued lap joints more economical from a production standpoint than taped joints (based upon a median quality and price of tape) and another had a diametrically opposite viewpoint. The latter company had converted one account from a reinforced, laminated paper tape to a glued lap joint and then had to revert to the taped joint because it was not possible to sell the glued joint boxes at the same price.

Of course, current cost relationships will not prevail indefinitely. Changes in raw material costs, in joint-forming machinery efficiency or, ultimately, in lap width requirements may alter the present picture.

The tests most frequently conducted on containers with different types of joints are compression, revolving drum, drop, and tensile. Compression tests are usually performed on boxes sealed empty although some have been conducted with sponge rubber as contents. It must be borne in mind that, unlike the case with stitched and taped boxes, the experience, both in the laboratory and in the field, with glued lap boxes has been relatively limited. With respect to rigidity the evidence to date is that glued lap boxes can resist compressive forces as well as containers with other joints. In some test projects, glued lap containers have had better rigidity and in others they have been inferior. In no instance, however, has the difference been very large in either direction.

Revolving drum and drop tests, naturally, presuppose the use of contents. Results of such tests which were definitive with respect to the differences between joints showed glued lap boxes to be more durable in two test programs and inferior to stitched boxes in another. More to the point, however, is the fact that in a much larger number of laboratory evaluations no distinction could be drawn among the various types of joints for the simple reason that other portions of the containers failed first. These other portions usually involved the scores (generally the horizontal but occasionally the vertical), the panels, and occasionally the flap closures even when the latter exceeded the minimum requirements of the Consolidated Freight Classification. The most significant point is that most of the boxes failed for reasons other than joint failure despite the fact that they were specially reinforced along all scores except the vertical edge directly at the manufacturer's joint. Reinforcement usually consisted of strips of heavy duty cloth tape although occasionally pressure-sensitive filament, reinforced tape was employed.

This phenomenon—that the manufacturer's joint is less vulnerable than other box parts—naturally will not prevail for all types of loads and for all types of tapes; those included in laboratory projects were reinforced paper tapes which were not the highest grade in their particular category. On the other hand, there seems to be sufficient evidence to indicate that the relative indestructibility of the manufacturer's joint applies to canned goods cases and to many other containers where the load either does not bear directly against the vertical edge at the joint or is so light that it sets up relatively innocuous stresses.

Experiments have been conducted to determine by means of revolving drum and drop tests the relative durability of glued and stitched joints after exposure for 2 weeks to a dry atmosphere (30% relative humidity at 120°F.) and after ex-

posure for 2 weeks to a damp atmosphere (90% relative humidity at 80°F.). No comparison could be established, however, because once again the containers failed at other portions, despite special reinforcement measures, with the joints still intact.

The last of the tests most commonly performed is tensile. Tension is applied to opposite ends of strips of combined board with the manufacturer's joint centrally located, the tension being perpendicular to the length of the joint. With the exception of one experiment, the tensile resistance of glued joints has been greater than that of either stitched boxes or taped boxes. It should be mentioned, however, that the types involved in the comparisons just mentioned did not include the heaviest cloth grades.

It can be questioned, however, whether these tests have much validity in a practical sense. Manufacturer's joint failures in the field almost always occur with the joined ends of the box blank more or less at right angles to each other instead of in the same plane and they usually result from a combination of tearing, shearing, compressive and tensile stresses rather than from any one individually.

Two other types of experiments have been conducted, although apparently on rather limited lines, on glued joints in comparison with one or the other of the competing types. The first involved submersion of box sections including taped and glued joints in room temperature water for a prolonged period of time. The insolubility in water of the adhesive used for the glued joint was definitely established since the bond was still intact after 24 hr. Contrariwise, the tape had "washed off" after a relatively limited period. It is only fair to mention, however, that tapes with water-insoluble adhesives are also available. More to the point, one may wonder how strong and protective any domestic type corrugated fiberboard box is after complete wetting for a few hours.

The other type of experiment was a modified tensile test conducted in a heating chamber. Strips of combined board with glued and stitched joints were suspended with known weights attached to the bottom ends. The temperature was then raised and it was observed that the joined sections of the glued-lap strips separated at approximately 130°F. while those of the stitched strips did not. A rebuttal has already been provided by a development engineer of an adhesives concern who stated that adhesives can be supplied for glued lap boxes which will not be thermoplastic at the temperature cited or even at those considerably higher. Furthermore, the point is of importance only to those with packaging problems which involve a combination of high temperatures and stresses on the manufacturer's joint.

We now enter the third field mentioned early in this presentation. Glued and stitched boxes have in common the extra lap or tab which imposes an additional thickness when the boxes are in a knock-down or flat condition. Even though the extra lap and the box panel to which it is fastened are compressed, and it has been stated that this compression can be carried farther with glued joints since the thickness of the formed stitch imposes a limit with the other type of joint, knock-down boxes of either of these two types will not lie as flat as taped boxes. Even though the extra lap and the box panel to which it is fastened are compressed, and this compression can usually be carried further with glued joints since there is no limit imposed as there is by the thickness of the formed stitch, knocked-down boxes of either of these two types usually will not lie as flat as taped boxes. This factor can materially affect storage and handling. It is only fair to report, however, that at least one company is able to stack knock-down glued lap boxes 15 ft. high without toppling potential and with the containers perfectly flat. As yet such flatness cannot be achieved by all manufacturers of glued lap containers.

Although the extra amount of fiberboard used for the lap or tab is not large, it does add to the tare weight of the containers. Moreover, there is a projecting edge or lap which can snag on protruding external objects if the lap is on the outside of the box or can interfere with packing of the merchandise if the lap is on the inside. In this connection, it has been claimed that glued lap boxes are preferred over stitched boxes by some concerns which have manual packing operations because there is less likelihood of injuries to personnel such as scratched or cut fingers, hands, wrists, or arms.

There is one consideration which does not directly concern the manufacturer's joint but which is intimately associated with it. This entails the bond or adhesion between the facings and the corrugations. Although this problem relates to the combining operation and although good inspection limits the number of boxes with faulty adhesion which get into the field, the condition can be affected by the manufacturer's joint. A stitched joint clinches all six components—the two facings and the medium of the lap and the two facings and the medium of the balance of the box blank—whereas the glued bonds only two components, one facing of each element.

Hence, a stitched joint inhibits separation of the corrugating medium from a facing more effectively than a glued joint. A taped joint falls between the other two in this respect since the inner facing is not restrained from separating from the flutes but the raw edges of the inner facing usually do not rub against each other or the contents. It would be wrong to magnify this consideration unduly since few poorly bonded containers are sold by reputable boxmakers. However, we have seen glued lap boxes in the field and in the laboratory with the joint intact but with the corrugations separated from one or both facings over a considerable area.

Two other advantages of glued lap boxes should be mentioned although they do not have universal application. If the lap is joined on the inside, the full area of all four panels can be used for printing. Also, glued lap joints are more readily formed on very small containers than stitched joints because the bulk of the stitching anvil occasionally produces unwanted creases in the box panels. This factor has caused a few government agencies buying small-sized interior weatherproof boxes—those of W rather than V grade—to waive the requirements of JAN-P-108 on certain occasions to permit the use of glued lap rather than stitched joints.

In summation, glued lap boxes have certain advantages and certain disadvantages as do corrugated fiberboard boxes with other types of manufacturer's joints. Insofar as the box user is concerned he should make his choice of manufacturer's joint on the basis of his own particular packaging problems and select that method best suited to his needs. The boxmaker, on the other hand, will be guided most in his decision whether or not to incorporate this feature into his production by the over-all economic factors.

Q. What check does the operator have on the effectiveness of the glued lap joint as the folded boxes come off the delivery of the folding machine?

A. Inspector can lay box aside and can see reading providing flap is on outside. However, if on inside more difficult. Some use mirrors. It is, therefore, important to watch film application.

Q. What is the determining factor for an inside or outside glue lap joint?

A. Customer preference is determining factor.

Q. How much of your recommended adhesive is consumed per 1000 in. of joint, or how far will 1 lb. of adhesive go?

A. No figures have been established. The adhesive is very thin and very high in solids content so that the coverage is twice that of pastes.

Q. Could a folder taper be converted to a lap gluing machine without difficulty?

A. Yes.

Q. How do you determine surface porosity as it affects gluing?

A. Have never determined surface porosity.

Q. How much adhesive to apply for a wet thickness of film of 0.003 to 0.005 in.?

A. At optimum speed must cut down amount.

Q. Will all glued lap boxes separate at high temperatures,

or is this a hit-and-miss proposition? Are they affected by subzero temperatures?

A. No experience of speaker with subzero temperatures. Depends upon adhesives.

Q. Will the glued lap joints hold on jute or filled kraft liners as well as it will on solid kraft liners?

A. Cannot answer directly. Glued lap has held well on most types of facings.

Q. Are the machinery manufacturers prepared to offer a means of squaring shallow depth boxes on semiautomatic gluers?

A. This is not an unexpected question. Manufacturers are developing such a machine.

Q. Has it been practical to glue double wall boxes? Would freight regulations of Rule 41 permit its use on 600 test double wall boxes?

A. Would guess that it is permissible. Rule 41 covers case.

Q. What are average speeds for the automatic folder glue lap machine and the hand-fed machine in cartons per minute?

A. Hand-fed speed is up to folder—in case of automatic folder machine at average speed is 70 to 80 per min. on no. 2 can case—peak speed at 123.

Q. Will the adhesive used on glue lap boxes settle in sewer lines leading from sinks used to wash out glue pans?

A. Would not recommend pouring glue down sewer line without adequate flushing—pigment in some glue can settle. Should flush line to prevent this.

Q. What minimum time requirement would you specify that the container be retained in compression section of machine?

A. Adhesive men should answer this question. Minimum time on conveyor 3 sec., on automatic machine up to 10 or 12 sec.

Q. (Part 1)—Describe the difference in strength between the four methods of attaching the glued lap: (1) lap on side panel attached to end inside; (2) lap on end panel attached to side panel inside; (3) lap on side panel attached to end panel outside; (4) lap on end panel attached to side panel outside.

A. In testing boxes, generally the joint does not fail first.

Q. (a) What, if anything, has been done about crushing the joint lap; how effective is it? (b) Have any tests been made to determine loss of compression strength by the crushing of tab and edge of panel?

A. (a) Two plants have been able to stack boxes up to 15 ft. (b) Crushing the tab and edge of the panel will impair the top-to-bottom compression. In can cases, for example, this is of little consequence.

Q. Have we been told that counter stackers cannot be used on glued lap boxes?

A. Not sure of question—does not see why they should not be used. Prefers counter that does not use back stop.

Q. What is the pressure in the compression section?

A. Does not know exact spring characteristics—will discuss individually.

Q. How many man-hours are required for cleaning up of gluing mechanism in its entirety? What effect does Summer freight car heat have on bond?

A. Amount of time required depends upon number of factors, such as: (1) design and (2) caliber of operator. Question cannot be answered categorically. No loss of bond due to high temperature in freight cars in Summertime—to best of my knowledge.

Q. What are the minimum panel sizes that can be handled on the semiautomatic machine?

A. Minimum panel size on semiautomatic machine for lap on outside is 4 in. on left side, 5 in. on right. Inside lap 4 in. on each side.

Q. Is it necessary to have complete coverage of the flap by the glue? How do you inspect a glue lap box to determine if the lap is completely covered?

A. According to Rule 41 entire flap must be covered—yes. Make proper setting and check occasionally to see that you have complete bonding as in other manufactured joints.

Q. On re-pulping waste containing glued laps, would the resin glues create unsatisfactory conditions on board machines producing lined boards?

A. Not qualified to speak on this problem. Resins, emulsions, and adhesives do not agglomerate or smear on re-pulping—will probably be dispersed completely.

Q. Does the presence of the glued lap on the inside of the case interfere with packing operations?

A. Depends upon way box is made. Often inside panels are used where product is not exactly rectangular, as in cans. Tab must be on outside for exactly reactangular packages unless adequate crushing of panel and tab have been performed.

Q. (a) Can a thermosetting urea-formaldehyde resin be used as the adhesive? (b) Is it being used at the present time?

A. (a) Frankly, no idea. (b) No.

Paper Problems of the Rotogravure Printer

ROBERT T. VAN DERVEER

When a gravure printer purchases paper from a supplier who may be either a mill or a distributor he expects that he will get a sheet that will print satisfactorily, and that the paper, in the form of rolls, will run acceptably over his presses. However, these two much sought after general attributes are often somewhat elusive, and getting the two together at one time is something that happens not nearly often enough.

Before we go into a discussion of paper problems as related to rotogravure printing, it might be well to briefly review some of the problems the gravure printer faces relative to having his product accepted and approved.

The advertising agencies and customers with whom the printer deals are, more often than not, extremely demanding as far as price and quality go, sometimes to extremes. In other words, top quality at bottom dollar. Many times they have a very hazy idea as to the capabilities and limitations of the gravure process which leads to much explanation on the part of the printer. The author has seen letterpress proofs on a paper, such as Chromcote, for matching, which of course can not be done as gravure cannot usually lay down ink or print successfully on the same kind of paper as letterpress.

How does all this affect the papermaker? To give one example: some time ago a prospective customer was shown samples of a regular 34-lb. rotonews, admittedly selected on the basis of color, finish, and absence of dirt, but none the less a sample from a regular commercial roll. As luck would have it, on the production run of the special size for the job, the mill had trouble with their sweat roll. Some of the rolls were fine, and others were so close to glassine as a result of being crushed that the result was ludicrous. The customer complained; we had to make an adjustment, and the mill had to do the same.

The above is a good example of why paper men and printers should have a better understanding of each others problems and capabilities. The mill undoubtedly didn't know that crushing the sheet would have such an adverse affect on this printed form or they wouldn't have passed it. It won't happen again, but how much better for everyone concerned if they had known it beforehand.

As mentioned before the rotogravure printer expects his paper will run and print satisfactorily, and with that thought in mind the remainder of this paper is devoted to a discussion of those factors which affect the aforementioned qualities of paper. Please bear in mind however, that all remarks deal exclusively with gravure magazine and newspaper supplement printing exclusively.

FACTORS WHICH AFFECT PRINTING QUALITY

As in any form of printing, the ultimate test of a paper for gravure work is to run it over a press. Paper tests are of value in predicting printability, but they must serve as an indication, not as a final judgment.

Certain physical attributes are of value to the gravure printer in predicting printability and perhaps the most important of these are: smoothness, compressibility, and compressibility ratio. The other commonly measured factors, such as brightness, color, opacity, and gloss, are of great importance also, but they affect gravure printing in the same manner as offset and letterpress and much information regarding their influence is already in the literature.

Smoothness, of course, is of primary importance to the gravure printer because of the inherent nature of the gravure process. The smoothness of a sheet must be in direct propor-

Robert T. Van Derveer, formerly with Triangle Publications, Inc., Philadelphia, Pa.; now, SKF Industries, Inc., Detroit, Mich.

tion to the fineness of screen used, or, the finer the screen, the smoother must be the paper. The reason for this is easily understood when one realizes that the surface of a piece of paper, no matter how smooth to the touch, is actually composed of ridges and valleys. If one uses a screen that is proportionally finer than the paper to be used, some of the cells will not print when they overlap a microscopic valley on the paper surface, and an inferior job will result.

The above is good as a general rule of thumb, but in actual practice in Dultgen gravure a 133-line screen is used for color work on super and rotonews, and a 170-line on the same paper for monotone. The theory behind this practice is that in seeking continuous tone reproduction all cells must print, and this is accomplished by using an impression pressure of such a magnitude that the paper is forced into the cells regardless of the surface smoothness. There are limits to this practice however, and having an inherent paper smoothness is much preferred to resorting to high impression pressures.

Compressibility, as measured by the compressibility ratio, is a most important prerequisite to successful gravure printing. Once again, this importance is directly related to the inherent nature of the gravure process. As is known, the ink-containing cells are recessed in the gravure cylinder, and the paper used must be physically capable of being squeezed into said cells, thus affecting a complete and rapid removal of the ink contained therein. If this were not so, loss of the tone would be considerable, particularly in deep etch areas.

Groundwood, more and more a constituent of fine gravure papers, imparts compressibility to a considerable degree with little sacrifice of other desirable printing qualities. The finest work is done on a paper containing 15 to 20% groundwood, but, of course, rotonews contains on the average 85%.

Compressibility is measured on the Gurley SPS Tester, computing it as the compressibility ratio. This, while not an accepted TAPPI test, works out very well, and the results are reproducible. The test is easily run by simply replacing the standard weight at the conclusion of the smoothness test with a heavier weight. In computing the result, the last reading is divided by the figure obtained for the smoothness test, and the result expressed as a ratio. For magazine paper this ratio is about 1.6 to 1, and for newspaper work, 2 to 1.

A printing defect not encountered too often in color gravure work is the moiré effect. This results when a pattern exists on the surface of the paper, put there by either the wire, dandy roll, or press and drier felts. This pattern creates an interference pattern with one of the screen angles used on the color separation positives with the net result that the particular color interfered with does not print well at all, especially in areas of small etch depth. This gives rise to a very disagreeable "checkerboard" effect, which, of course, is unacceptable.

Moiré effect can be caused in processing color work if the predetermined screen angles are not closely adhered to, and this possibility should always be checked first when the condition arises. If a pattern does exist in the paper there is no other recourse except to change the lot.

If a pattern does exist in the paper, it is often very difficult to detect, the only way being meticulous visual inspection. If a pattern is found it must be determined if it is of such an angle to interfere with a particular nonprinting color.

PRODUCTION REQUIREMENTS

Good running form his production rolls is perhaps more important to the gravure printer than the printability of the paper. For the latter it is usually possible to make some adjustment in his processing, such as etch depth, impression pressure, screen fineness and so on, but once the job has begun it is usually roll and paper condition that determines whether he will have a good, fair, or downright poor run.

The list of pitfalls is a long and lengthy one, ranging from slack ends to sulphur. All have one common result: they slow production with attendant increases in costs and tempers.

Sulphur in paper is, of course, intolerable. If an appreciable amount exists in the order of 8 to 10 p.p.m., complete loss of tone is inescapable; the only remedy is a complete cylinder makeover. The first effect of sulphur is usually a small tonal loss, accompanied by a slight darkening of the copper cylinder. At the onset of this phenomenon, the pressman will notice that he is losing tone in the affected areas. Usually he suspects that his ink viscosity has fallen and adds more base color. This is no remedy at all, of course, and the situation rapidly grows progressively worse. If the amount of sulphur present in the paper is of a small magnitude considerable tonal loss usually occurs but does not disappear entirely. However, with a sulphur content of over 10 p.p.m., complete loss of tone is inescapable if the job is continued.

The chemistry of the above phenomenon is simple. Reducible sulphur and copper combining to form copper sulphide which causes a grayish or black deposit on the surface of the cylinder.

Once a sulphur condition is discovered there is little that can be done to correct it outside of changing the paper lot and registering a strong protest with the manufacturer. However, sulphur trouble oftentimes has a tendency to be spotty, showing up in perhaps two or three rolls of a series, and not in others. Here only trial and error by laboratory tests on the offending series is of value.

Sized paper seems to have a somewhat lower tolerance for a given amount of sulphur than does a waterleaf sheet, perhaps due to the increased activity coefficient of the sulphur ion. For that reason a carbonate loading is preferred, keeping the pH value of the sheet somewhat on the alkaline side.

At Triangle Publications both the silver and copper accelerated tarnishing tests are used for a qualitative result, and the American Optical test for a quantitative figure. It is the paper manufacturers' responsibility when sulphur trouble occurs, and he in turn can make sure that no questionable paper ever leaves his mill by representative sampling and checking to make sure that any sulphur content of his paper is well below the point where it will cause the gravure printer any trouble.

Another paper defect peculiar to the gravure industry is the presence of abrasive particles in the sheet. These particles caught between the doctor knife and the surface of the cylinder, scratch the cylinder, and then the scratch proceeds to print on each succeeding revolution. These scratches are one of the bugaboos of gravure printing, and while by no means are they always attributable to paper, paper in many cases contributes more than its just share of trouble.

To give an example: a job was recently run for a customer who furnished a make of paper not commonly used in our plant for the particular job. Within a few hours of commencing the run a very strong complaint was registered by quality control over the abnormally high amount of comets and scratches. Naturally, every variable was suspected at first with no particular emphasis on paper, but the paper proved to be the culprit. Microscopically sized particles of aluminum oxide from the grinder stones of the offending mill were found both in the paper and etched areas of the cylinder. Naturally, we had encountered the same trouble before, but here the magnitude of frequency was several times greater than in any other case on file. In fact, we continued to have scratch trouble on those particular presses for the next two succeeding runs.

Here again it is the paper manufacturers' sole responsibility to control the amount of abrasive material in his product.

Perhaps the specific defects included in the general category of "mechanical roll defects" cause the gravure printer more grief than all the other deficiencies combined. You are undoubtedly familiar with many of them, and usually they are as troublesome to the offset or letterpress printer as to the gravure.

Some of these are: wrinkles, both of the atmospheric and built-in varieties, slack centers and ends, tight centers and ends, starred rolls, slime holes, and defective, improperly made up, or unflagged splices.

Wrinkles as mentioned above can be of two general types: the kind due to atmospheric conditions, sometimes called "moisture welts" and those due to improper manufacturing techniques, whether put on at the paper machine or at the final rewinding. For the latter there is no cure except to rectify the faulty phase of manufacture which is always possible by a mill that is actively interested in keeping its quality standards at a high level.

Those wrinkles caused by atmospheric conditions are usually found in a sheet that is wound tightly, and hence as it takes up moisture, can only expand across the length of the roll giving rise to the characteristic welds. These wrinkles almost invariably will cause a color job to run out of register for the duration of their existence, and many times will fold over and break going through the various impressions. They are particularly annoying in a sheet that is highly stressed in the machine direction or that possesses inherently low tensile strength, because the usual remedy is to increase the amount of tension on the web.

Fortunately, moisture welt problems need not be very much of a problem if the paper manufacturer is willing to take an additional step in the packaging of his rolls. At Triangle Publications it was found that if a moisture vapor barrier was applied to the rolls at the rewinder, wrinkles due to moisture welds were practically eliminated. By following this technique the white waste losses, that is, paper stripped off the rolls before running, was cut approximately 60%.

The type of barrier does not seem to influence the amount of protection afforded. Equally good results were obtained with a vinyl-chloride-acetate copolymer, a 50-lb. heavily waxed sulphite, and the conventional 30-30-30 laminated asphalt kraft. Of course, the determinant factors are the moisture vapor transmission rate and price of the barrier. It is interesting to note that the additional cost of the laminated kraft and the wax wrap were absorbed by two suppliers. It was felt that any additional costs involved were more than offset by the greatly lessened frequency of complaints.

There are important secondary benefits also obtained by the use of a moistureproof wrap, namely the lessened frequency of tight ends (slack ends on the press) and a much longer retention of paper moisture under conditions of storage at low humidities.

No theory has been advanced for the former phenomenon, inasmuch as it is counter to current thinking on the subject, but the result is nevertheless observable.

Tight and slack centers and ends are readily observable in any gravure plant and are in the first rank of roll defects. When such a condition is discovered in a roll or series of rolls the press must immediately be slowed down and such adjustments as are possible made. These adjustments include cocking the guide rollers, increased tension, and so on. More often than not a bad wrinkle will result and many times cause a break. If the conditions were static within a roll or series of rolls that would be one thing, but one end may run slack for a few moments and then switch to the other. This of course, necessitates a complete change of press adjustments, with a consequent loss of valuable production time. Rolls are run in sequence as to the side of the machine they come from as a matter of course, but in a defective series of rolls this procedure has no ameliorating effects, leading to the conclusion that the defect, if mill caused, was not peculiar to the paper machine. In fact, such defects seem to be strictly a function of subsequent processing and nothing else.

However, it is well nigh impossible to detect defective centers and ends in most cases, both good and bad rolls having the same sound when rapped. This fact enormously complicates the inspection problem and in most cases renders the problem of separating the wheat from the chaff virtually impossible. In a case such as this, the only solution is trial and error after all obvious discrepancies have been taken care of. After a series of complaints, the mill will often turn out good rolls and claim they have no knowledge as to what caused the difference. If such is the case, the good rolls are probably the result of a general tightening of manufacturing standards all along the line. In any event the pressroom personnel can safely be approached once more.

Miscellaneous defects such as starred rolls, slime holes, defective splices, and improper car loading are all of such a nature that the solution is usually fairly obvious, and a little cooperation and frankness between the paper manufacturer and printer will straighten out the matter to everyone's satisfaction.

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Application of Multiple Correlation Methods in the Pulp Mill

F. L. RILEY

Multiple correlation techniques offer a means of determining the relationship between a pulp characteristic and several of the process conditions which might affect it. These relationships often cannot be explained by simple linear correlation methods because the changes in the quality characteristic are often not due predominantly to one condition but frequently to several processing conditions acting independently or jointly. In this case the relationship with any one factor can be obscured because of the variation of the other factors. By using multiple correlation methods the amount and significance of the variation in the quality characteristic due to each condition under consideration may be determined, as well as the amount of variation in the quality characteristic that is explained by all of the factors being considered.

MULTIPLE CORRELATION

No attempt will be made in this paper to go into detail on the mathematics involved in multiple correlation. Textbooks (*1*) are available dealing with this subject. Briefly, multiple correlation is the derivation of an equation which determines the line of best fit for the data being analyzed. This line is said to fit the data best because it is the one in which the sum of the squares of the deviations from the plotted line is at a minimum. The regression equation shows the change in the dependent factor for every unit change in each of the independent factors selected for study, excluding the effect of the other selected independent factors. Statistical tests can then be applied to determine the significance of the correlation between the dependent factor and each independent factor and also to determine how much of the variation in the dependent factor can be explained by all the selected independent factors being studied.

The following problem is an example of the use of multiple correlation methods.

The data presented in Table I have been simplified but represent a portion of the weekly averages of a pulp quality characteristic and the three manufacturing conditions believed to have the most influence upon it. The quality characteristic, the dependent factor, will be designated as X_1 and the process conditions, the independent factors, will be designated as X_2, X_3, and X_4. The problem is:

1. To determine the amount of change in the quality characteristic due to each of the selected process conditions.

F. L. Riley, Quality Control Engineer, Brown Co., Berlin, N. H.

Table I. Simplified Data

Quality characteristic, dependent variable	*Processing conditions, independent variables*		
X_1	X_2	X_3	X_4
9.0	5.6	9.2	5.6
8.5	7.6	4.8	5.4
3.4	6.4	0.8	6.4
3.2	6.8	2.8	4.2
3.8	8.0	2.8	4.4
7.4	6.8	5.2	1.4
5.8	6.4	6.8	1.8
5.6	8.8	6.0	2.0
6.4	9.0	8.8	1.0
5.0	7.0	6.4	1.6

Note: This represents only a portion of the data used to derive the regression equation. A larger amount of data is necessary to ensure dependable results.

2. To determine the significance of the correlation between the quality characteristic and each of the selected process conditions while excluding the obscuring effect of the other selected independent factors.
3. To determine how much of the total variation in the quality characteristic has been explained by the three process conditions.
4. To make use of the knowledge obtained to secure better control of the quality characteristic.

Scatter diagrams were constructed in which the values for the quality characteristic X_1 were plotted against values for each of the three process conditions, X_2, X_3, and X_4. These are shown in Figs. 1, 2, and 3.

Figure 1 shows a considerable amount of scattering about the line of regression but there is evidence of relationship existing between X_1 and X_2. The upper and lower dashed lines in the diagram are plotted at two standard errors of the estimate from the regression line. The standard error of the estimate indicates how closely values of the dependent factor, in this case the quality characteristic, can be estimated for any particular value of the independent factor, in this case the process condition. Plotting the lines two standard errors from the regression line means that approximately 95% of the values of X_1 predicted for any value of X_2 would fall between these two lines.

There is some evidence of correlation in Fig. 2 but it is even less than in the previous scatter diagram (Fig. 1). This is indicated by the wider scattering of points and the decrease in the slope of the regression line.

The scatter diagram in Fig. 3 shows practically no evidence of any relationship between the quality characteristic and the X_4 condition.

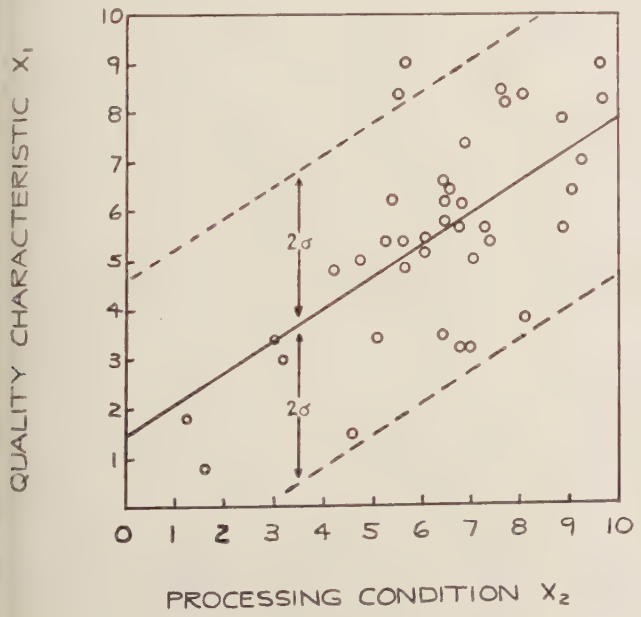

Fig. 1. Scatter diagram X_1 *versus* X_2

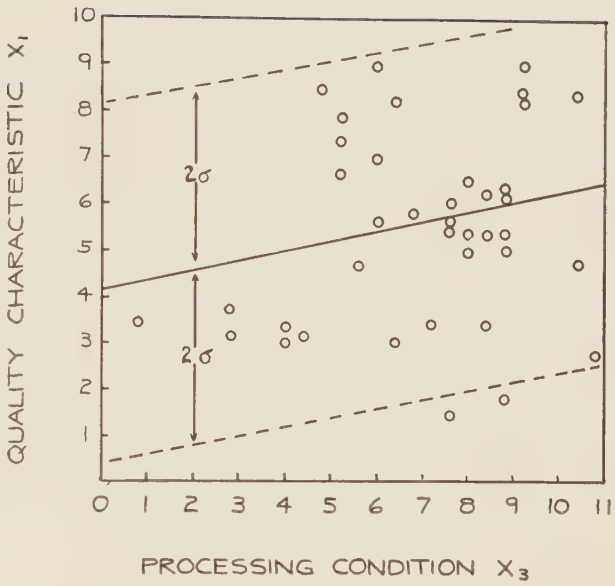

Fig. 2. Scatter diagram X_1 *versus* X_3

MULTIPLE REGRESSION EQUATION

A simple linear correlation on the data in Figs. 1, 2, and 3 shows the apparent relationship between the quality characteristic and each of the process conditions. If two of these conditions could be held constant, however, the relationship between quality characteristic and the remaining condition might be closer. For example, the change in the quality characteristic due to the X_4 condition would be very close to zero as the regression line explaining the relationship would be nearly horizontal. However, if the other two factors could be held constant the relationship between X_1 and X_4 might be better.

Therefore, in order to explain the relationship between the quality characteristic and the three selected conditions it was necessary to use the method of multiple correlation. By using this method the effect of one condition on the quality characteristic can be determined while the other two conditions are held mathematically constant. This provides a means of determining the relationship where it is not possible to hold all of the factors constant while varying the one being studied as is frequently attempted in the laboratory.

The following equation explaining the relationship between the quality characteristic and the three conditions was derived:

$$X_1 = -2.57 + 0.81X_2 + 0.38X_3 + 0.07X_4$$

This equation is the one which explains the relationship most

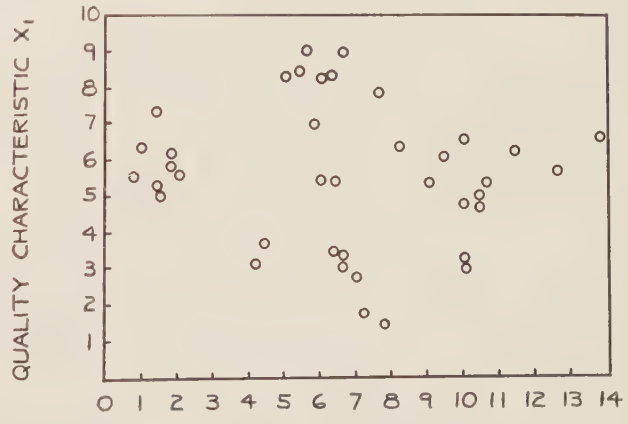

Fig. 3. Scatter diagram X_1 *versus* X_4

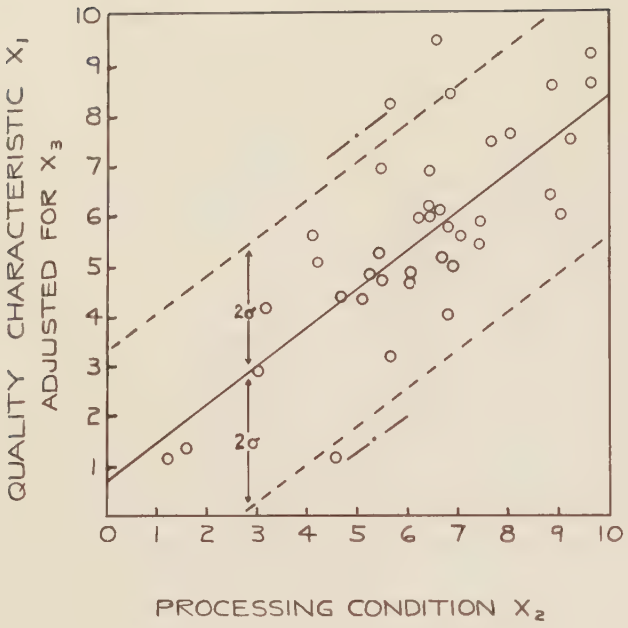

Fig. 4. Correlation of X_1 versus X_2 when variation due to X_3 is removed

correctly. The first constant fixes the height at which the line crosses the Y axis. The coefficients before each of the independent variables, the process conditions, show the average change in X_1 for each unit change in the process condition; the coefficient being determined while excluding any variation in X_1 due to effect of the other selected conditions.

The equation showed the greatest amount of change in the product quality to be due to the X_2 and X_3 factors while the amount of change associated with X_4 was small.

Statistical tests of significance were applied to determine: first, the correlation between the quality characteristic and each process condition while eliminating any tendency of the remaining selected process conditions to obscure the relation; and, second, to determine what proportion of the variation in the quality characteristic has been accounted for by the three conditions. The relationship shown by the regression equation was found to be very significant as were the regression coefficients for X_2 and X_3. The coefficient for X_4 was not significant and the small coefficient obtained

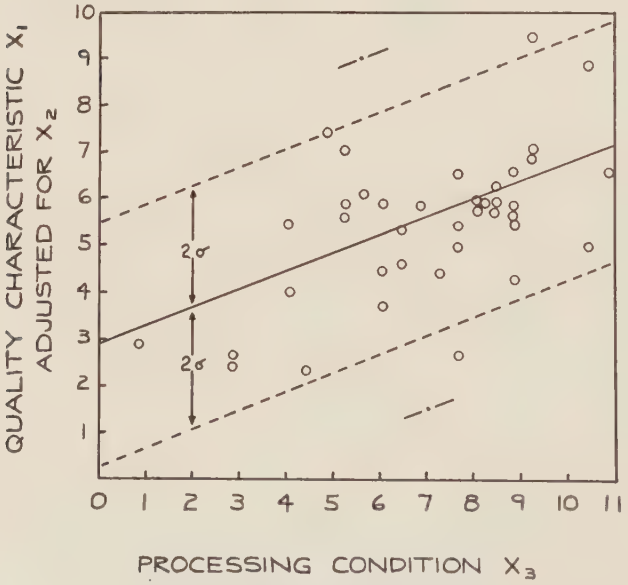

Fig. 5. Correlation of X_1 versus X_3 when variation due to X_2 is removed

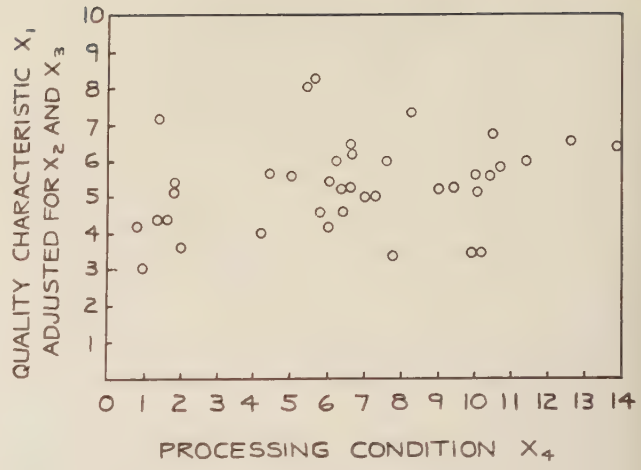

Fig. 6. Correlation of X_1 versus X_4 when variation due to X_2 and X_3 is removed

could have been due to the operation of chance causes and not necessarily to any correlation.

In order to show how the correlation increases as the influence due to the other factors is eliminated the values for X_1 were adjusted for the influence of X_3 and plotted against X_2 (Fig. 4). The decrease in the standard error of the estimate as the variation due to X_3 is accounted for is shown by the difference between the dashed lines at two standard errors of the estimate and the dash-dot-dash line which represents two standard errors before X_1 was adjusted. In Fig. 5 the values for X_1 were adjusted for the influence of X_2 and plotted against X_3. The decrease in the standard error of the estimate is denoted by the difference between the dashed lines and the dash-dot-dash line representing two standard errors before adjustment.

In Fig. 6 the values for X_1 were adjusted for the influence due to X_2 and X_3 and plotted against X_4. Adjusting for the influence of X_2 and X_3 has narrowed the spread of the points but there is no correlation shown as was determined by the tests for significance on the regression coefficient for X_4.

The fact that X_4 showed no significant effect on the quality characteristic was surprising because it had been believed to have considerable influence. This factor is costly to con-

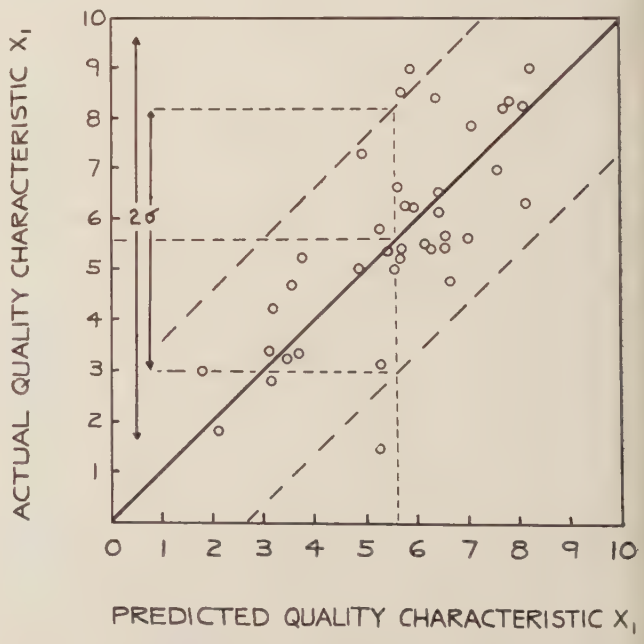

Fig. 7. Actual versus predicted values. Decrease in variability of quality characteristic due to controlled conditions

trol and the knowledge that it does not influence the quality characteristic is valuable from a cost standpoint.

Using the original data given for the independent factors, the predicted values for X_1 were determined by the regression equation and plotted against the actual values as shown in Fig. 7. The central line on this chart is drawn at a 45° angle so that the more variation accounted for in the quality characteristic the closer the points will cluster about this line.

If other factors can be found that have a significant relation with X_1 more of the variation will be explained. If no other significant factors can be found the conclusion indicated will be that the variation is due to a large number of small causes and will have to be lived with.

Application of the Relationship

We can make use of the knowledge which has been shown by use of multiple correlation techniques in this way. The process condition X_3 is subject to better control than the X_2 condition. The desired aim for the quality characteristic is 5.6. Substituting the value 5.6 for X_1 in the regression equation, omitting the factor X_4 which was not significant, and solving in terms of X_3 yields the following equation:

$$X_3 = 21.6 - 2.1X_2$$

This equation gives the change to make in X_3 to adjust for the variation in the X_2 factor to yield the desired aim (predicted value) in the product characteristic. By making this adjustment approximately 95% of the product quality will lie on the segment of the vertical dotted line intercepted by the two standard error lines shown in Fig. 7. This results in a decrease in the variation as shown by the difference between the two vertical lines on the left side of the chart (Fig. 7) indicating two standard errors when the process conditions are allowed to vary and when they are controlled.

LITERATURE CITED

1. Ezekiel, M., "Methods of Correlation Analysis," 2nd ed., New York, N. Y., John Wiley & Sons, 1950.

Pulp Bleaching with Sodium Chlorite

R. L. CARR and K. S. MACLEOD

THE role of sodium chlorite (C2) and chlorine dioxide in the bleaching of pulps has been discussed in its various phases in previous papers. The fact that these bleaching processes are now in regular commercial operation bears out the results of earlier research on chlorite and chlorine dioxide which indicated that in these selective oxidizing agents a new tool was available to the pulp industry. The purpose of this paper then, is to review the processes and techniques which have been developed to utilize these bleaching agents, and perhaps contribute something from our experience with them.

While the terminology "sodium chlorite bleaching" is commonly used, under actual bleaching conditions it must of necessity become "chlorine dioxide bleaching" since the chlorite is always used in conjunction with acid, chlorine, or hypochlorite, any one of which reacts with chlorite to produce chlorine dioxide. The following are typical of these "activation" reactions:

1. Chlorine activation:

$$2NaClO_2 + Cl_2 \rightarrow 2ClO_2 + 2NaCl$$

2. Acid activation:

$$5NaClO_2 + 2H_2SO_4 \rightarrow 4ClO_2 + 2Na_2SO_4 + NaCl + 2H_2O$$

Hypochlorite activation:

$$2NaClO_2 + NaOCl \rightarrow 2ClO_2 + Na_2O + NaCl$$

Chlorine dioxide may also be obtained from sodium chlorate by reduction in acid medium with a suitable reducing agent. Sulphur dioxide and methanol are the reducing agents commonly used. The Kesting process, an electrolytic reduction of chlorate, has had some limited use in Europe.

With regard to the chlorine activation of sodium chlorite, another term which might well be defined at this point is "mixed gases." This refers to a mixture of chlorine and chlorine dioxide which is obtained by reacting with sodium chlorite an amount of chlorine in excess of that normally required to make the reaction go to completion. In this manner any desired ratio of chlorine to chlorine dioxide may be obtained.

C2, which is the trade name of the commercial sodium chlorite product available to the pulp and paper industry, has been successfully adapted to the bleaching of flax, rag, sulphite, and kraft pulps over the past few years. While, obviously, the ultimate use of each of these pulps differs, the basis for employing a chlorite bleach is common to all, maximum brightness consistent with high strength retention.

FLAX PULP

Chlorine dioxide bleaching of flax pulp is usually carried out by either chlorine or acid activation of chlorite. Flax tow is given a caustic soda–sodium sulphide cook and washed. This pretreatment is basically the same in two mills in which, however, the bleaching processes differ somewhat and are outlined below:

Mill A

Chlorination: wash
Caustic extraction: wash
C2 stage: C2, 9-lb. per ton uncooked tow
Chlorine, 4.5-lb. per ton uncooked tow
Run at 125° F. for 3 hr.

In this case the yield is 37% based on uncooked fiber and the viscosity (cuproammonium) 150 cp.

Mill B

Chlorination, plus H_2SO_4 to pH 1.8: 2.0
C2: 25–50 lb. per ton, bleach for 2 hr.
Caustic to pH 10–10.5

Run for 2 hr. at 120°F.

This procedure produces a pulp with a particularly high viscosity and fold strength, properties necessary for its intended use.

It is noted that in the first case there is a definite second stage in which chlorite is activated by chlorine. In the second case, however, the bleach is essentially a single-stage operation divided on a time basis into an acid chlorination, acid chlorite, and alkaline chlorination stage in which the residual chlorine is converted into hypochlorite. The presence of chlorite and/or ClO_2 in the pulp provides protection against degradation particularly as hypochlorite is formed just above the neutral point in the transition from acid to alkaline bleaching.

RAG PULP

The bleaching of rag pulp with chlorite has been a standard procedure in some mills for the past few years. As in the case of flax, a high-strength, high-brightness pulp is required. A typical procedure for rag bleaching is the following:

Rag, from boiler: washed
Bleach liquor added: 7–13 gal per ton, white rag
20 gal per ton, colored rag
Acid (or alum) to maintain pH 8.5–9.0
Bleach 30 min.
Recirculated in bleacher for 1 hr., then pumped to the wet lap machine
Bleach liquor make-up: 250 lb. NaOH
960 gal. H_2O
150 lb. Cl_2
50 lb. C2

The advantages provided by this process are: (1) more stable bleach liquor (NaOCl instead of $Ca(ClO)_2$), (2) bleaching pulp viscosity the same or higher than unbleached, and

R. L. CARR and K. S. MACLEOD, Mathieson Chemical Corp., Baltimore, Md.

(3) copper number reduced from 0.40 (OCl bleach) to 0.15 (C2 bleach).

A procedure published some years ago outlines the bleaching of rag stock in a beater or washer, using the hypochlorite activation method as noted above. For white rags the following is quite suitable:

Rag, from boiler: washed
Buffer (soda ash–soda bicarbonate): pH 9.2
Add bleach liquor: 0.25% av. Cl_2 on weight of rag
1:1 ratio NaOCl:C2 (av. Cl_2 basis)
Bleach 30 min.

In a mill where this procedure was used on white rag stock the bleach time was reduced to 30 from the 90 min. normally required with hypochlorite. At the same time the brightness was significantly improved and the fold strength increased 12%.

While on the subject of rag pulp a few details concerning a process developed specifically to meet the requirements of one mill might be of interest. Rag mills, faced with a decreasing supply of good cotton rags due to the rapidly increasing consumption of synthetic fibers, are forced to bleach a much lower grade material than they are normally equipped to do. The bleaching process devised for a mill which had to handle waste and sweeps from cloth and thread manufacturing was this:

Caustic cook, 3% NaOH plus detergent: 8–12 hr.
Wash: 2 hr. cold, in washer beater
Oxalic acid to remove iron
Wash: $^1/_2$ hr. cold
Pulp to bleach chest
Chlorite bleach: 25 lb. C2 per 3000 lb. pulp
pH 4.5 with HCl temp. 160°F. for 3 hr.
Bleach pulp pumped to wet lap machine

The development of this procedure provided the mill in question with a simple, economically attractive process by which to bleach a very low-grade raw material to a good quality pulp.

Another raw material available to rag mills, although in somewhat short supply, is cotton linters. One mill has installed a continuous system for bleaching linters and made use of the following procedure:

Refine 4 hr. with 1.0% av. Cl_2 as $Ca(OCl)_2$
Wash: 0.5% Cl_2 40 min.
pH 2.0
Wash: 0.5% av. Cl_2 as $Ca(OCl)_2$ at 100°F.
2 hr. ClO_2 + $Ca(OCl)_2$
The bleached pulp had an 82 G.E. brightness

Some further experimental work on this process proved that by using 1% chlorite in the chlorination stage the brightness could be increased from 82 to 87 with a marked improvement in tear, burst, and fold values.

Thus far, in discussing flax and rag pulp bleaching, we have considered only bleaching operations which are normally carried out batchwise and in one or at the most two stages. In coming to the consideration of sulphite and kraft pulps we enter the field of continuous multistage bleaching with all its attendant variables, and hence the answers to the questions of when and how to use chlorite or ClO_2 are somewhat more difficult to obtain. As with the other pulps, some general principles can be outlined which will serve as a guide in establishing the proper procedures for individual mills.

KRAFT PULP

The conventional sulphate bleach plant using chlorination, caustic extraction, and one or more hypochlorite stages has produced satisfactory pulp with good strength characteristics. In recent years, however, new uses have been developed for sulphate pulps which made further pulp purification essential. Additional purification essentially means higher brightness levels, but there is a limit in hypochlorite bleaching beyond which the degradation of the cellulose outweighs the improvement in color. The properties of selective oxidation without fiber degradation which makes chlorite a desirable bleaching agent for rag and flax can thus be used to advantage in bleaching kraft pulps also.

The use of chlorine dioxide in one or more stages of the bleach plant has been extensively investigated both on a laboratory and mill scale in this country but has probably reached its highest state of development in Sweden where the process has been in commercial use for several years.

There are too many variables in a sulphate mill, starting with the type of wood and carrying on right through pulping and bleaching operations to be able to lay down any hard and fast rules for chlorite or chlorine dioxide bleaching. Since, however, the greatest drop in pulp values normally occurs in the final hypochlorite stage, this would appear to be the logical starting point for chlorine dioxide. Probably the best example of this approach to the mill scale adoption of chlorite is in the work done by the Nekoosa-Edwards Paper Co. This mill has a five-stage bleachery (which is to be expanded to six) in which the pulp is treated as follows: chlorination, low density; caustic extraction, hot, high density; hypochlorite, high density; caustic extraction, hot, soak, high density; and hypochlorite, low density. Under normal operations the bleached pulp showed good strength retention and averaged about 79.0 G.E. brightness. When attempts were made to raise the brightness levels through further hypochlorite bleaching, an appreciable loss of strength occurred. Several trial runs were made using chlorite, chlorine dioxide, and mixed gases in one or more stages.

It might be mentioned at this point that the idea of using chlorine in conjunction with chlorine dioxide was shown to have certain advantages over chlorine dioxide alone in alkaline medium. Mixed gases in a ratio of not less than 1:1 produce a pulp having characteristics of a ClO_2 bleach without the degradation characteristic of chlorine or hypochlorite. The mixed gas process also offers some economic advantages in the form of lower chemical cost and a somewhat quicker bleach.

Of the experimental work on Nekoosa-Edwards kraft the following runs are typical:

1. 0.51% av. Cl_2 as mixed gases applied at a ratio of 3.3 ClO_2 to 1 Cl_2 in fifth stage. pH allowed to drift, with a final value of 6.7. Brightness increased 9.5 points from preceding hypochlorite stage to a final 82.3 G.E. brightness. The final viscosity of the bleached stock (cupraethylenediamine) was 10.5 cp., with an over-all strength retention of 90%.
2. 0.51% av. Cl_2 applied in the fifth stage as mixed gases at 2:1 (ClO_2:Cl_2) ratio. pH 9.1. Final G.E. brightness 82.7 and viscosity 8.8.
3. 0.5% av. Cl_2 applied in the fifth stage as mixed gases at 1.5:1 (ClO_2:Cl_2) ratio. pH 7.4. This resulted in a final G.E. brightness of 81.2 and pulp strength retention of 90.9%.

It may be seen from the above results that applying mixed gases at various pH levels and varying ratios of chlorine dioxide to chlorine in place of the final hypochlorite bleach produced a pulp of higher strength and brightness.

A fully bleached kraft pulp of 70.0 brightness was being produced at another mill with a five-stage bleach plant using a slightly different bleach cycle: chlorination, low density; chlorination, lime neutralization, high density; caustic extraction, hot, high density; hypochlorite, low density; and hypochlorite, high density. The application, in place of the final hypochlorite stage of 0.5% available chlorine was a mixed gas ratio of 2 parts ClO_2 to 1 part Cl_2, produced a bleached pulp with an average G.E. brightness of 81.5 which exhibited 100% strength retention. Also the use of mixed gases in the low density fourth stage followed by the normal hypochlorite stage enabled them to obtain an 83 G.E. brightness pulp with excellent strength retention.

Giertz, in a paper published in *Tappi*, May, 1951, went into some detail on the theory and mechanism of the reactions involved in pulp bleaching. Based on certain of these theories he outlined a procedure for bleaching kraft pulp to approximately 90 G.E. brightness with essentially complete strength

etention based on the brown stock. This procedure involved: chlorination, alkaline extraction, "double treatment" (hypochlorite), alkaline extraction; chlorine dioxide, alkaline extraction, and chlorine dioxide.

The so-called double treatment consists of impregnating the pulp with an excess of hypochlorite in the second stage and, after a period of alkaline reaction, acidifying the stock. The unconsumed hypochlorite is thus converted into chlorine and the balance of this stage becomes an acid chlorination.

Chlorine dioxide bleaching is now in regular use in a kraft mill where it is applied in the final stage to acid pulp. It is thus producing a high quality bleached kraft pulp of 88 G.E. brightness. The bleach cycle in this mill is as follows: chlorination, caustic extraction, hypochlorite, caustic extraction, hypochlorite, and acid chlorine dioxide. Reports from this mill indicate that the use of 0.5 to 1.0% ClO_2 in the final bleach raises the brightness from 65 (which is obtained in the preceding hypochlorite stage) to 88. Color stability and pulp strength values are excellent.

SULPHITE PULP

Sulphite pulps are normally very easy to bleach as is evident by the fact that most sulphite bleach plants operate only two or three stages. Chlorination, caustic extraction, and one hypochlorite bleach usually are sufficient to produce a pulp of good brightness. The additional purification required to produce dissolving pulps of high quality entails further bleaching which, if carried out with hypochlorite, involves degradation of the pulp and a loss in alpha-cellulose content. Without going into detail it is sufficient to say that the various methods of bleaching with chlorite as already outlined are just as readily adaptable to sulphite as to other pulps, and result in comparable strength protection and brightness increases. Of the various mills using chlorite or chlorine dioxide the largest is probably the Temiskaming, P. Q., mill of the Canadian International Paper Co. which was also the first mill on the continent to develop and install its own chlorine dioxide generating plant.

An interesting sidelight on the bleaching of sulphite pulp is provided by some work done during the chlorine shortage of a year or so ago. A sulphite mill, whose chlorine supply was inadequate, wished to replace as much chlorine as possible with available chlorine as chlorite. The possibilities for chlorine savings were in the chlorination or hypochlorite stages as the mill each plant was set up with: chlorination, 1.5% av. Cl_2; caustic extraction, 0–1% NaOH, and hypochlorite, 1.7% av. Cl_2 as $Ca(OCl)_2$. It was found that up to 75% of the chlorine in the first stage could be replaced with chlorite, the total available chlorine being reduced by 40%. A pulp of 83.9 G.E. brightness and excellent strength properties was obtained by this method. Thus an experiment made necessary by a chlorine shortage proved not only that chlorite could be substituted successfully for elemental chlorine, but also that in so doing it produced a bleached sulphite pulp of equivalent and in some instances higher brightness levels, excellent strength retention, and a reduction in the total available chlorine applied, as compared to previous operations without chlorite.

ACID BLEACHING

The foregoing discussion of the various methods of bleaching with chlorite or chlorine dioxide has been almost entirely confined to bleaching on the alkaline side. Actually, the use of chlorite by acid activation or the application of chlorine dioxide to acid pulp produces superior results. On the alkaline side the reduction of ClO_2 stops at $NaClO_2$, thus permitting the effective use of only one fifth of the total oxidizing capacity of chlorine dioxide. The full oxidation capacity of the ClO_2 may be utilized in acid medium. Generally speaking the conditions for acid bleaching are:

Temperature: 60–80°C.
pH: 3.5–5.0
Time: 2–3 hr.
Concentration: 0.5–1.0% av. Cl_2 as ClO_2

The practical limitation to the use of acid chlorite in many mills is the lack of suitable corrosion-resistant equipment since chlorine dioxide in acid solution is highly corrosive to normal mill equipment. Acidproof bleach towers and stock chests and high-grade (preferably no. 317) stainless steel washers are essential if an acid process is to be used. While such equipment represents additional capital outlay it is readily justified by the resulting product—an exceptionally bright, strong pulp with excellent color stability. There are, at the present time, four mills in Canada, and at least two in this country, using acid chlorite or chlorine dioxide bleaching processes on kraft or sulphite pulps.

EQUIPMENT

The utilization of a new chemical or process normally infers that additional equipment will be necessary. The use of sodium chlorite as a bleaching agent does not necessarily entail equipment beyond the existing bleach plant facilities with the exception of the generation of mixed gases, and at that the installation is neither elaborate nor costly. For mixed gas generation, chlorite solution is prepared in a holding tank, preferably equipped with an agitator. Gaseous chlorine is supplied from a regular evaporator and controlled by a rotameter on the line. The chlorite is fed at a predetermined rate by means of a proportioning pump. The two reactants meet at a tee in the line and immediately form chlorine dioxide or the desired mixture of chlorine dioxide and chlorine in solution. This solution goes directly into the stock line or bleach tower.

Materials of construction include no. 316 stainless steel for the chlorite solution tank, Hastelloy C for the proportioning pump and check valves, saran or saran-lined steel pipe for the feed lines. The entire installation should not require a capital expenditure of more than $3000 to $3500 and can readily be undertaken by mill personnel.

Sodium chlorite, in flake form, is packed in 100-lb. iron drums which can be stored readily and stock solutions prepared as required. C2 is now also available in the form of 50% chlorite liquor shipped in 8000-gal. tank cars. While the utilization of chlorite liquor necessitates storage capacity at the mill for 10,000 to 15,000 gal. it naturally represents a lower chemical cost and eliminates the labor of solution make-up in the bleach plant.

OTHER CHLORINE DIOXIDE PROCESSES

While on the subject of equipment it might be well to mention briefly the various other processes for generating chlorine dioxide. As mentioned earlier these all involve the reduction of sodium chlorate. The first of these processes to be used for pulp bleaching is the Holst process which was first set up in Husum, Sweden, in 1946. This is a direct reaction between sodium chlorate and sulphur dioxide in sulphuric acid medium. Production is normally batchwise but can be made continuous through the addition of a spare reactor.

The Persson process, which is a modification of the Holst, is in use at the Stora mill in Sweden. This process utilizes a so-called "reduction moderator," which is a chromium salt, to promote more efficient reduction of the chlorate than with SO_2 alone. The process is either continuous or batch and produces Glauber's salt as a by-product.

The Solvay generator uses methanol as the reducing agent for chlorate instead of sulphur dioxide.

All three of these processes require the erection of separate facilities to house the generator or reaction vessel, and to wash, store, and supply the resulting chlorine dioxide solution to the bleach plant. A capital investment in the neighborhood of $150,000 is required for such an installation.

The Kesting or Brown Co. (electrolytic) process is a variation of hydrochloric acid reduction of chlorate wherein the reaction is intentionally carried only halfway to completion. Chlorine and hydrogen are burned and the HCl so produced

is mixed with air and reacted with chlorate produced in an electrolytic cell. ClO_2 and Cl_2 are obtained and the partially spent chlorate liquor is returned to the cell for fortification by further electrolysis. While raw material costs are low and the per pound cost of the ClO_2 so produced is lower than from other processes, the capital investment in plant equipment is estimated in the range of $500,000 per ton-day of chlorine dioxide.

The choice of a suitable process to produce chlorine dioxide depends upon the conditions and requirements of a particular mill. Such factors as the type and quantity of pulp to be bleached, whether the production of such pulp is to be continuous or intermittent, the amount of chlorine dioxide to be applied to the pulp and the desirability of capital expenditure, all have to be weighed before any process can be adopted.

LITERATURE CITED

1. Brennan, McMahon, and Vincent, *Paper Trade J.* (Nov., 1942).
2. Vincent, G. P., *Paper Trade J.* (June, 1947).
3. Stone, W. A., and Matarese, J. G., *Paper Trade J.* (Nov., 1948).
4. MacLeod, K. S., *Pulp Paper Mag. Canada* (Feb., 1950).
5. Giertz, Hans Wilhelm, *Tappi* (May, 1951).
6. Reid, D. M., *Pulp Paper Mag. Canada* (Oct., 1951).

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Values of Acidic Reducing Agents in Kraft Bleaching

H. B. CHANNON

When we were asked to present a paper at the New Hampshire-Maine Section of TAPPI meeting, we were not sure whether or not we were ready to present the data on the work that is still uncompleted. What we do present here is, therefore, essentially in the manner of a progress report. At a later date we would be very happy to present our final findings. What we thought we could present at this time would be a complete picture of some of the field work, some of the established procedures, and a digest of published information so far available. This is to stress and bring into greater relief the importance that sulphur dioxide plays in this process, for it has been apparent from some of our field effort, in the last three years, that northern pulp and paper mills may not have caught the significance of its use, and the values that have accrued.

The kraft process with the subsequent extraction and bleaching stages have now been in vogue in the South for a number of years. The procedures involved are well established and what remains to be done is a greater perfection in the extraction and separation of the lignin, noncellulose compounds, and color bodies from the cellulose itself. In this effort for perfection during the period that has elapsed, certain chemicals, for certain reasons or another, so far as their properties are concerned, have won out, so to speak, in their competition with other chemicals. One is, therefore, apt to take their use for granted and lose sight of the fact why they still maintain the prominence they do.

In the removal of color bodies, one reaches the point where it becomes inadvisable to continue with the oxidation stages, simply because more complete destruction of the cellulose takes place with losses as are not economically justifiable. To cope with this problem, one has to reverse the principle of color removal, simple oxidation, and use pure reduction. It is here where the value of a reducing agent, particularly one with marked acid characteristics, comes into play and adds its specific valuable and important properties in completing the bleaching results.

H. B. Channon, Manager, Technical Service Dept., Virginia Smelting Co., West Norfolk, Va.

This can be illustrated rather clearly by observing the problem of removing indigo from denim. Here we have an organic chemical, a very stable dye, that resists severe oxidizing influences, so much so that the cotton fiber in which it is impregnated or dyed is deteriorated to a great extent before the dye is completely decomposed or destroyed. This, of course, is inadvisable; consequently, to preserve the fiber, one uses a new set of conditions and with the aid of a strong reducing agent, the color is first solubilized and then made colorless so that in subsequent steps it can be removed completely by proper treatment and washing. This is the general principle applied at the end of the hypochlorite stages of kraft bleaching when sulphur dioxide is used. Colorless compounds are formed that are soluble. These are consequently easily removed by washing with the additional value that if proper reaction time is allowed, stability of color is developed and reversion does not take place. Further, there is actually an increase in brightness that is separate and distinct from the brightness developed by the oxidizing agent previously used.

TYPICAL pH AND G.E. BRIGHTNESS LEVELS IN KRAFT BLEACHING

The typical pH and G.E. brightness levels in kraft bleaching at various stages are noted in Figs. 1 and 2.

It should be noted that the kraft process with the subsequent extraction and bleaching stages, with the exception of the chlorine extraction stage, is conducted essentially on the alkaline side. It is interesting to note that the variation in pH and that of G.E. brightness is somewhat marked, particularly the abrupt rise in G.E. brightness during the hypochlorite bleaching stages. This is accomplished through either a single or a two-stage addition of the hypochlorite. In the case of the latter, the hypochlorite is added in two steps, generally with a thorough washing after each. However, in some cases washing may not take place after the first step.

The chlorine extraction is essentially a chlorination stage where soluble compounds are formed, which are washed out prior to the alkali extraction. It does appear that in the alkali extraction and in the first step of the hypochlorite bleach that the greater bulk of noncellulose material and color bodies remaining, after digestion, are removed. The second bleaching step completes the degree of G.E. brightness increase desired with not too much color removal.

One arrives at the end of these stages after the stock has been washed to a pH of 8.5 where it is inadvisable, because of further degeneration of the cellulose, to apply oxidation further, whether it be on the alkaline or acid side of 7. If the stock is left in this condition, reversion takes place and a matter of 4 to 6 points can be expected in the lowering of the G.E. brightness.

The proper handling of the stock at this point has developed a natural use for liquid sulphur dioxide with a further increase in G.E. brightness from the use of the material itself. The general principle for handling the sulphur dioxide here has been fairly well determined and worked out. Before we take up a discussion of the evidence why sulphur dioxide at this point is preferred over other chemicals that have been, or can be, used, it would be enlightening to discuss the procedure and control of the sulphur dioxide addition.

PROCEDURE FOR HANDLING SULPHUR DIOXIDE AND CHARACTERISTICS OF THE REDUCING BLEACH

The classic example of procedure (Figs. 3 and 4), or what one is told is done, is the lowering of the pH through at least $2^1/_2$ points of pH and arriving at a pH level of 6. In actual practice the pH is, in most cases, lowered into ranges of 5 to $5^1/_2$. Then, allowing a reaction time to take place of at least 1 to 2 hr., the pH rises and stabilizes at 6. Under these conditions the pH must be lowered rapidly, a fact that is developed very readily from the use of such an acidic reducing agent.

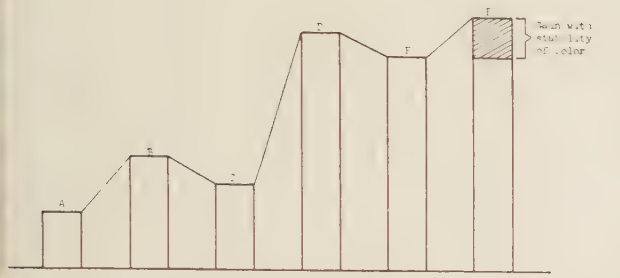


Fig. 1. Typical pH and G.E. brightness levels in kraft bleaching

Pulp: A—from digester; B—Cl extraction; C—Alkali extraction; D—end of hypochlorite bleaching; E—end of reducing bleach; F—reversion loss.

Through the use of the sulphur dioxide at this stage an increase in brightness of at least $2^1/_2$ points average can be realized; greater increases have been obtained. This variation in the G.E. points of brightness increase is the direct result of the variable condition of the stock, and the method of handling prior to the stage where the sulphur dioxide is added. These unknowns are being examined at this time and a report on this can be presented later when the work is completed.

The sulphur dioxide requirement is from 5 to 8 lb. minimum, 12 to 16 lb. maximum, per ton of pulp. The requirement again is affected by the character of conditioning which the pulp has had up to the time the sulphur dioxide is added; also, by the character of the pulp, type of wood, age, etc. There appears to be an irreducible minimum required before one can develop the maximum G.E. brightness obtainable.

In some instances the pH must be lowered to about 4 before maximum brightness increases are obtained. In these instances the stock may require some washing to bring it up to the ranges of 6. However, it is preferred that the process be conducted so that the proper reaction time elapses with no washing before the stock is moved forward onto the machine.

It is to be realized that lower acidities, developing from the use of sulphur dioxide, are essentially fugitive. It does not seem to have the tenacious fixation property with the cellulose that appears to be the case with mineral acids, such as hydrochloric or sulphuric. Even though the stock sometimes has a relatively low pH, lower than 6, at the paper machine, by the time the paper is off the drying cans the pH is back to the desirable range.

Characteristics of the Reducing Bleach Following the Oxidizing Bleach

1. Lowering the pH to the break point of G.E. brightness.
2. A reaction time of at least $^1/_2$ to 2 hr. maximum.
3. A rise in pH to affect a minimum of 2 points change in pH.
4. An increase in G.E. brightness of 2 to $2^1/_2$ points average.
5. A classic example is to start at 8 to $8^1/_2$ and lower the pH down to at least 6.
6. Stabilization of color.
7. In some cases an increase in G.E. brightness of stock in storage.

SULPHUR DIOXIDE REACTIONS

The reactions below take place progressively and we can assume, instantaneously, as the sulphur dioxide in the desirable quantities is added. One of the first reactions to take place, which is probably the most significant, is that with the hypochlorite residuals remaining. Please note that as a result of this reaction oxidation by hypochlorite is immediately stopped. There are small amounts of hydrochloric and sulphuric acids developed which are insignificant yet they can be considered as assisting in the neutralization of the alkali by the sulphur dioxide.

1. Between the SO_2 and the hypochlorite:
   $Ca(OCl)_2 + 2H_2SO_3 = CaSO_4 + 2HCl + H_2SO_4$
2. Between acids formed and alkali present:
   (a) $Ca(OH)_2 + 2HCl = CaCl_2 + 2H_2O$
   (b) $Ca(OH)_2 + H_2SO_4 = CaSO_4 + 2H_2O$
3. Between the SO_2 and the alkali present:
   (a) $Ca(OH)_2 + H_2SO_3 = CaSO_3 + 2H_2O$
   (b) $Ca(OH)_2 + 2H_2SO_3 = Ca(HSO_3)_2 + 2H_2O$
4. Between the SO_2 and water:
   $H_2O + SO_2 = H_2SO_3$

Acid salts of the alkali present are also formed and particularly as the pH of the stock, influenced by the addition of the sulphur dioxide, reaches those pH's where these acid salts are apt to be formed (between $3^1/_2$ to 5). Sulphurous acid, as such, is not formed until pH's fall below 3. As the experience here does not indicate the advisability of going so far, sulphurous acid, therefore, does not appear as such, except under fleeting conditions when the sulphur dioxide comes in contact with the water and is first dissolved. Sulphurous acid then is only the reacting compound or the carrier of the sulphur dioxide in the reactions above.

SODIUM BISULPHITE VERSUS SULPHUR DIOXIDE

Figure 4 presents the curves developed by solutions of sulphur dioxide and sodium bisulphite at different molarities. One will note that under the same conditions the bisulphite solution varies from 4.1 to 5.1 in pH, while sulphur dioxide varies from 0.91 to 3.02. This stresses the fact that sodium bisulphite lacks the total acidity to effectively lower the pH rapidly. The first hydrogen radical, the stronger of the two present in sulphurous acid, has been neutralized and is not available. Consequently, whereas bisulphite will develop similar results as does sulphur dioxide, it results in a more expensive chemical to use. In practice two and one-half times as much in equivalent weights is required.

It is of interest that earlier patents on the process did stress the use of sodium bisulphite (Baker, U. S. 1,468,693; Kress, 1,645,061; Kress, 1,651,530; Schuber, U. S. 1,820,502). By 1941 interest in liquid sulphur dioxide had developed and essentially after this date the use of sodium bisulphite was discarded.

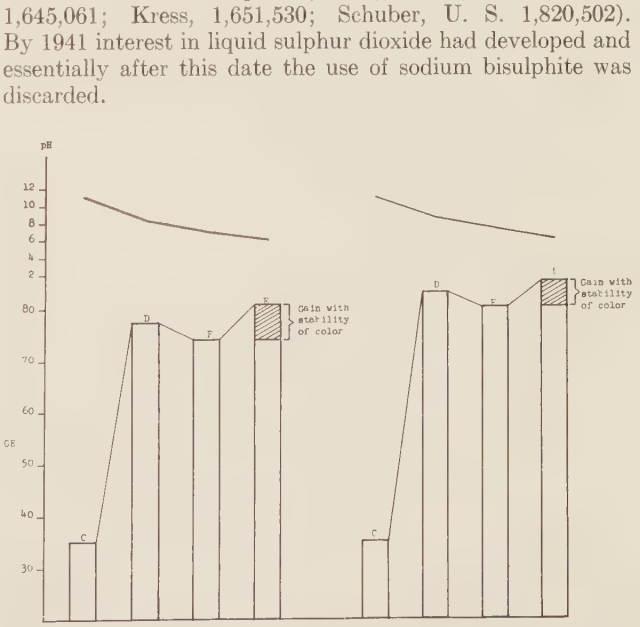


Fig. 2. Typical pH and G.E. brightness levels in kraft bleaching

C—alkali extraction; D—end of hypochlorite bleaching; E—end of reducing bleach; F—reversion loss.

SULPHURIC ACID VERSUS SULPHUR DIOXIDE

The use of a mineral acid, such as hydrochloric or sulphuric, and particularly the latter, has attracted considerable attention because of its lower cost. In spite of many and notable attempts to use them in substitution, sulphur dioxide is still to be preferred. The reasons why this is so are interesting and informative.

In the first place, it should be realized that such an acid as sulphuric, when added in moderate amounts and carefully controlled, a procedure that is required under such circumstances, converts the alkali, hypochlorite, over to hypochlorous acid, and thus continues the oxidation process, which is not desirable. Even though there is an increase in G.E. brightness resulting, the cellulose is deteriorated to such an extent that the brightness increase is offset.

$$Ca(OCL)_2 + H_2SO_4 = CaSO_4 + 2HOCL$$

Should the hypochlorite be in considerable amount, the sudden addition of sulphuric acid will cause it to be decomposed with the formation of water and the release of chlorine.

$$2HOCL = 2HCL + O_2$$
$$HCL + HOCL = H_2O + Cl_2$$

Such a reaction was observed in years past by the textile mill bleacheries, when sulphuric acid was used in what was known as "the buck sour." The release of chlorine was so prevalent and the odor so strong that the concept gained was that it took a real male "buck" to supervise and handle the process. The practice of using sulphuric acid as an antichlor in such textile bleacheries has in most instances long since been replaced by the use of sulphur dioxide. Eventually experience indicated that sulphur dioxide was safer since no tendering of the cellulose would result.

BRIGHTNESS AND STABILITY OF COLOR

As has been mentioned, when sulphur dioxide reacts with the hypochlorite oxidation stops immediately. The natural question that arises is then how does the additional increase in G.E. brightness (flash bleaching) develop? We are in the midst of studies to evaluate this interesting result. We can only give at this time a theoretical interpretation of what takes place. One might easily explain the phenomena by stating that the color bodies are similar to color indicators. These, as one well knows, change color within a definite pH range. This explanation appears to be inadequate for if sufficient reaction time is allowed, stability of color is developed to a considerable degree. There are three reactions that have been observed to take place when reducing agents are applied under such conditions.

1. The conversion of the color compound to the leuco base:

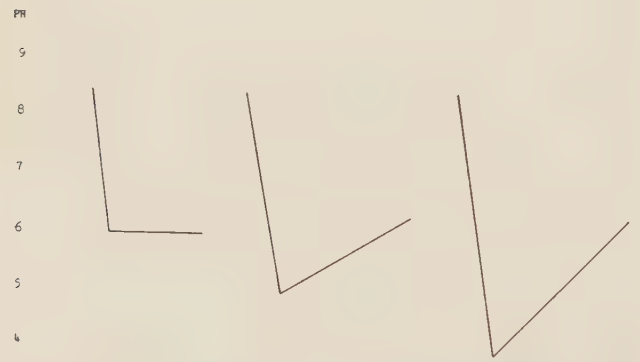


Fig. 3. Acidic reducing agent influences in kraft bleaching

Cases I, II, and III—78–81 G.E. brightness range.
G.E. brightness increase—2½ points.
Reaction time—1–2 hr.
SO_2 requirement—5–8 lb. min. to 12–16 lb. max. per ton of pulp

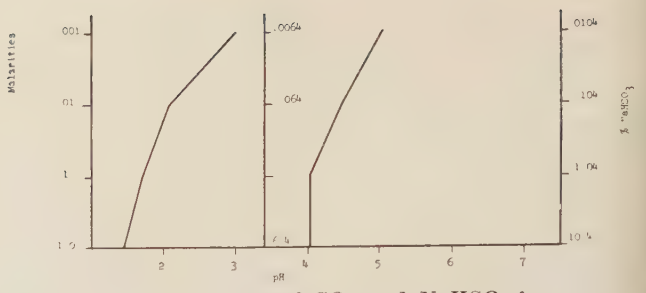
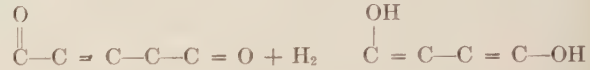


Fig. 4. Concentrations of SO_2 and $NaHSO_3$ in aqueous solution yield the corresponding acidities given as pH values at 25°C.

Molarities	*% SO_2*	*pH*	*% $NaHSO_3$*	*pH*
0.001	0.0064	3.02	0.0104	5.1
0.01	0.064	2.15	0.104	4.5
0.01	0.64	1.47	1.04	4.1
1.0	6.40	0.91	10.40	4.1



2. Through esterification a sulphurous acid ester is formed with a color body, or organic chemical developing color characteristics:

$$R — OH + H_2SO_3 = R — OSO_2H + H_2O$$

3. The sulphurous acid combines directly with the double-bonded carbon, with a rearrangement of bonds as shown:

$$R — C = CHR' + H_2SO_3 = \underset{\underset{SO_3H}{|}}{RCH} — \underset{\underset{H}{|}}{CHR'}$$

Just what happens has not yet been determined, but it is assumed that the reaction taking place is more likely to be one of the latter two. The significant factor is that these reactions, between sulphurous acid and the color body, provided a suitable reaction time is allowed to elapse, develop a soluble and rather stable colorless compound, with properties, so far as the pulp is concerned, that progressively increase the brightness while in storage.

There is evidence to indicate that the third reaction takes place more readily should a sodium or calcium ion be present. In this case the hydrogen ion indicated would be that of either sodium or calcium. One can see that if either ion is required this is obtained directly from the acid sulphites also formed between the sulphur dioxide (as sulphurous acid) and the hypochlorite. Consequently there is no use for a sulphite with a high, free sulphur dioxide content as such. This is developed *in situ*. Sulphur dioxide, therefore, has these many additional properties that have enabled it to become more advantageously used at this stage of kraft step bleaching.

SUMMARY

In kraft bleaching one reaches a point where it is inadvisable to continue with the oxidation principle in removing color. The use of a reducing agent, such as sulphur dioxide, effectively stops further deterioration of cellulose from oxidation itself, and in turn converts the color bodies to colorless and soluble compounds. If a proper reaction time is allowed a high degree of stability of color develops. The "flash" bleaching or increase in G.E. brightness that results when the sulphur dioxide is properly handled can be attributed to one of three possible reactions with the color bodies present. Which one of the three is more likely has not yet been determined, as the research work has not been completed. Further findings of interest will be published later.

PRESENTED at a meeting of the Maine-New Hampshire Section of the Technical Association of the Pulp and Paper Industry, Portland, Me., Nov. 7–8, 1952.

The writer wishes to acknowledge at this time the assistance and cooperation that was given during the field tests by T. C. Warren, International Paper Co., Ticonderoga, N. Y.; M. S. Anderson, Oxford Paper Co., Rumford, Me.; and W. Ruffin, North Carolina Pulp Co., Plymouth, N. C.

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Fourth Coating Conference, Netherland Plaza Hotel, Cincinnati, Ohio, May 25–27, 1953.

Second Conference on Application of Statistical Methods in the Pulp and Paper Industry, Western Michigan College, Kalamazoo, Mich., June 15–26, 1953.

Tenth Fibrous Agricultural Residues Conference, Trenton, Ontario, October 8–9, 1953.

Third Corrugated Containers Conference, Statler Hotel, New York, N. Y., October 15–16, 1953.

Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

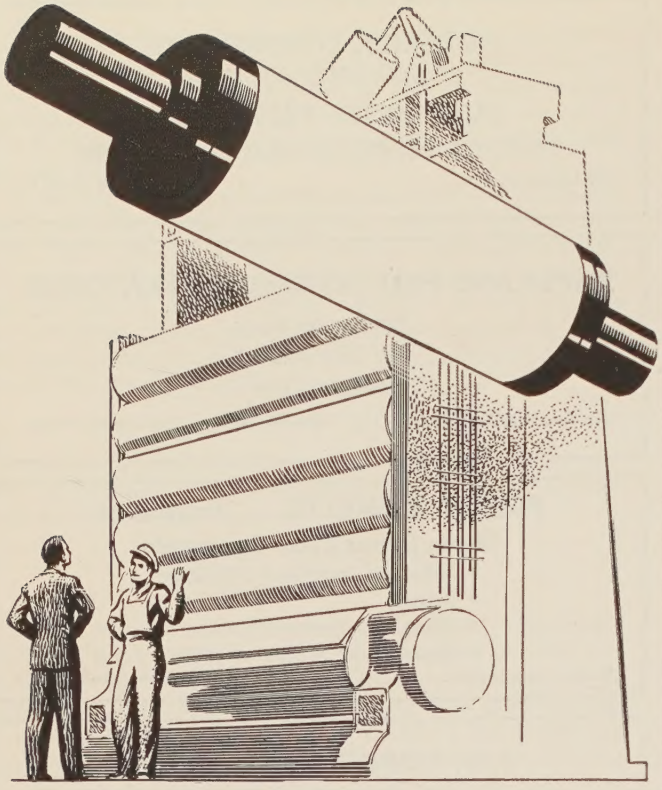
Thirty-ninth Annual Meeting, Commodore Hotel, New York, N. Y., February 15–18, 1954.

EMPIRE STATE SECTION:

Whiteface Inn, Lake Placid, N. Y., June 8–10, 1953.

NEW ENGLAND SECTION AND MAINE—NEW HAMPSHIRE SECTION:

Poland Spring House, Poland Spring, Maine, June 19–20, 1953.



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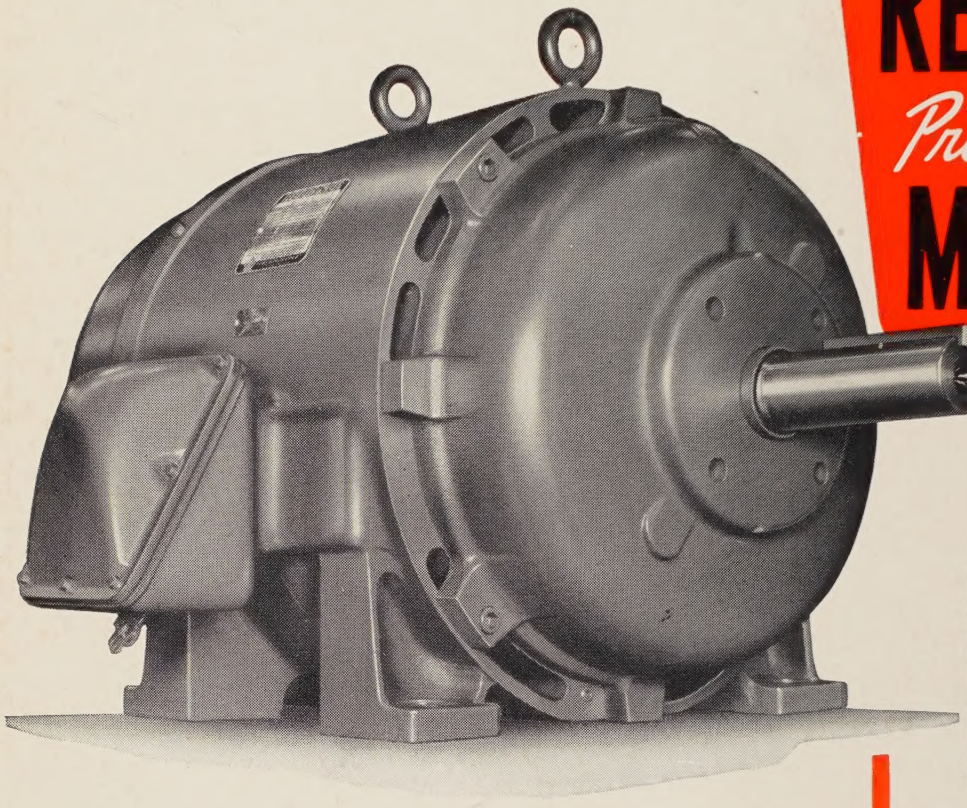

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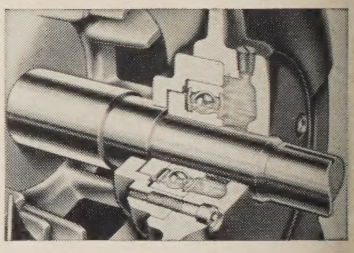

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